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PROCEEDINGS OF THE WORLD SCIENTIFIC CONFERENCE on the BIOLOGY AND CULTURE OF SHRIMPS AND PRAWNS

Mexico City, Mexico, 12-21 June 1967

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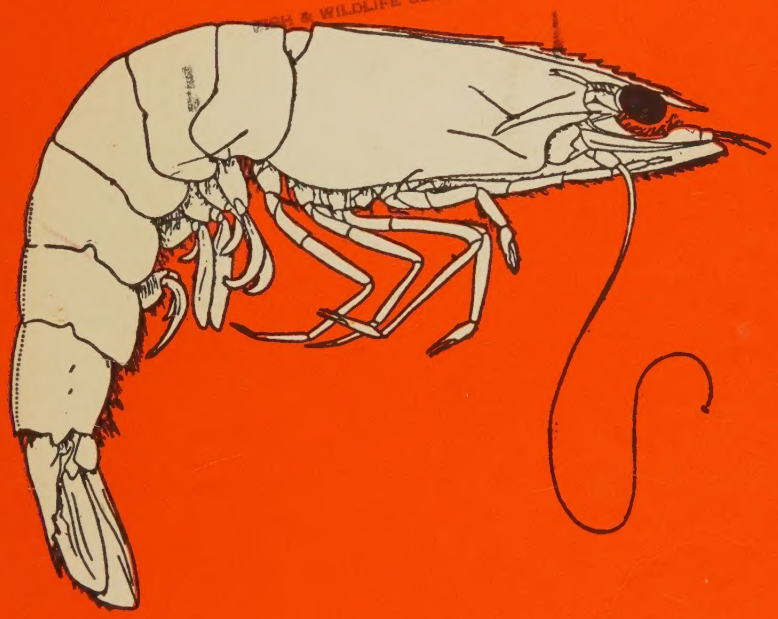

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, 1968

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PROCEEDINGS OF THE WORLD SCIENTIFIC CONFERENCE

ON THE

BIOLOGY AND CULTURE OF SHRIMPS AND PRAWNS

Mexico City, Mexico, 12 - 21 June 1967

Edited by

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VOLUME I - REPORT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, June 1968

PREPARATION OF THIS REPORT

This volume is the revised version of the Draft Report, which was distributed to the participants of the World Scientific Conference on the Biology and Culture of Shrimps and Prawns, in Mexico City, Mexico, 12 to 21 June 1967. The subsequent volumes of the Proceedings will contain the review, regional summary, experience, and species synopsis papers contributed to the Conference. Information papers, circulated as background material, will be excluded.

The views expressed in the papers and reports are those of the contributors and participants and not necessarily those of the Food and Agriculture Organization of the United Nations.

Dr. C. P. Idyll, Chairman of the Conference, helped in editing the report.

Distribution

FAO Department of Fisheries
FAO Regional Fisheries Officers
FAO Member and Associate Member Nations
Participants and Contributors
Regional and Intergovernmental Bodies
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Conference report. Report of technical sessions. Resource appraisal. Life history. Physiology and behaviour. Statistics of catch. Stock assessment. Culture. Participants. List of documents.

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1. ORIGIN AND OBJECTIVES

The value of holding a world scientific conference devoted to the biology and culture of shrimps and prawns was recognized by interested scientists and regional fisheries councils and commissions more than a decade ago. Problems related to shrimp and prawn research were being treated on an area basis and some degree of inter-regional coordination was highly desirable. During a ten-year period, 1948 to 1958, world shrimp and prawn production had increased by 25 percent, and the necessity of exchanging knowledge between scientists and experts on the rational exploitation, management and conservation of these resources became apparent. In addition, interest in the culture of these organisms by government-controlled research institutes and private industry had increased further.

The importance of convening an international conference of this character was endorsed by the Twelfth Session of the FAO Conference in 1963, recommended by the FAO Advisory Committee on Marine Resources Research (ACMRR) at its Second Session, February 1964, and finally approved by the Thirteenth Session of the FAO Conference in 1965. The world scientific meetings on Sardines and Related Species (Rome, 1959), and on Tunas and Related Species (La Jolla, 1962), both convened by FAO, had contributed immensely to bringing together all available information on the exploitable species and on the research implemented, and also had assisted in orienting FAO's program of work in these specialized fields. In addition, such a conference was regarded by FAO as a contribution to the International Biological Program (IBP), and was accordingly co-sponsored by the Marine Productivity Section of the Special Committee for the IBP under the International Council of Scientific Unions (ICSU).

The Government of Mexico graciously offered to be host to the Conference, and through the agencies of its Ministry of Industry and Commerce gave the maximum support to all the local arrangements, as well as publicity, both nationally and internationally. The premises of the Medical Centre of the Mexican Social Security Institute and a full complement of experienced conference staff were made available.

When it became known that the International Shrimp Council (ISC) and the Shrimp Association of the Americas (SAOTA) planned to convene their joint annual meeting in Mexico City from 8 to 10 June 1967, arrangements were made for the FAO World Scientific Conference to follow on from 12 to 21 June. The concurrence of the two meetings, each originating from a different concept but basically of a complementary nature, was considered advantageous to both scientists and representatives of the industry.

Preparatory work for planning the World Scientific Conference on the Biology and Culture of Shrimps and Prawns was initiated in the spring of 1964. Investigators actively engaged in shrimp research and culture were requested to suggest the scope and objectives of the Conference, and a Consultative Group was established to assist FAO in the planning and organization. In selecting the members of this group, which would carry out its work through correspondence, due consideration was given to adequate geographic and subject representation:

Dr. E. E. Boschi (Argentina)
Dr. D. J. Crisp (United Kingdom)
Mr. E. W. Ellis (San Salvador)
Dr. M. Fujinaga (Japan)
Dr. D. N. F. Hall (United Kingdom)
Dr. L. B. Holthuis (Netherlands)
Dr. C. P. Idyll (U. S. A.)
Dr. S. Jones (India)
Dr. J. H. Kutkuhn (U. S. A.)
Dr. A. R. Longhurst (U. S. A.)
Dr. M. Massuti (Spain)
Mr. M. N. Mistakidis (Chile) 1/
Mr. I. S. R. Munro (Australia)
Mr. G. de Neiva (Brazil)
Dr. M. Nikolic (Cuba)
Dr. H. G. Oroutt (U. S. A.)
Mr. R. Ramirez Granados (Mexico)
Mr. A. Rifaat (U. A. R.)
Dr. I. A. Ronquillo (Philippines)
Mr. A. C. Simpson (United Kingdom)
Mr. E. Smidt (Denmark)
Dr. Tham Ah Kow (Malaysia)
Dr. K. F. W. Tiews (Federal Republic of Germany)

1/ At that time an expert under a UNDP/SF Project assignment

As a result of correspondence exchanged, it emerged that the scope of the Conference should include all biological aspects, including detection methods and statistics, of species: (1) for which there is a substantial fishery; (2) for which there is good reason to believe that national stocks are adequate to form the basis of a substantial fishery; and (3) which are being cultivated or which would appear suitable for culture.

The final agenda items which developed into discussion sections were:

Resource appraisal

Life history

Physiology and behaviour

Statistics of catch and effort

Stock assessment

Culture of shrimps and prawns

Standardization of research methods

FAO Indicative World Plan (IWP) survey of crustacean resources

All sections were to be discussed in Plenary Session, except the last, which was established as a Working Party, and convenors and rapporteurs were to be nominated for each section.

The objectives of the Conference were identified as the review, application and assessment of: (1) known scientific facts, (2) gaps in knowledge, (3) theories and concepts, (4) methods and equipment, and (5) to offer a scientific basis to the development of a strong fishing industry. In addition the Conference would consider and recommend future lines of endeavour in the studies of biology, exploitation and culture of shrimps and prawns, particularly on aspects of world-wide interest and application, such as:

Identification, distribution, life history, behaviour in relation to environment

Population parameters, scientific survey and assessment of stocks, fluctuations, methods of capture and behaviour related to capture

Current exploitation, potential fisheries, rational utilization

Specific problems and outlook for future international cooperation

Means whereby such international action could be made possible

The majority of the above objectives could not be achieved without appropriate background documentation and members of the Consultative Group and selected scientists were asked to prepare, in advance of the Conference, species synopses, review papers, regional summary papers and experience papers.

2. PROCEDURAL MATTERS

Matters pertaining to procedure were discussed at a meeting, held in Mexico City on 11 June 1967, of the officers of the Conference and members of the Consultative Group who could attend (Appendix 1). The provisional agenda (Appendix 2) was approved and it was agreed that each convenor should present at the opening of his session a summary of the relevant technical papers. Authors would then be invited to give a brief resumé of their contribution, after which the subject would be held open for discussion.

The task of the rapporteurs and the procedure for establishing working parties were examined; it was decided that convenors of agenda sections and of working parties should submit their reports and recommendations for discussion and approval in the plenary session.

A Sub-Committee was established to decide which of the papers presented should be included in the Proceedings of the Conference which FAO intended to publish later.

It was decided that the order of speakers during the inaugural session would follow Mexican protocol. Due to the absence abroad of Lic. O. Campos Salas, Minister of Industry and Commerce and Honorary President of the Conference, and Lic. J. Echaniz Ruvalcaba, Director-General of Fisheries, their place would be taken by Lic. P. García Reynoso, the Ministry's First Sub-Secretary, and Lic. A. Cervantes Delgado, Deputy Director of the Ministry's Department of Economic and Fisheries Affairs.

2.1 Inaugural session

Before delivering the opening address (Appendix 3), Lic. Cervantes Delgado read a telegram sent by the Honorary President, regretting his inability to inaugurate the Conference and wishing it every success. Dr. S. J. Holt, Director of the Fishery Resources and Exploitation Division of FAO's Department of Fisheries, then spoke on behalf of Dr. B. R. Sen, Director-General, (Appendix 4). Lic. P. García Reynoso, representing the Mexican Government, formally declared the Conference open and expressed the hope that its findings would contribute to the solution of the problems encountered in increasing the world's food supply.

The Conference having been declared open, the Representative of the Director-General of FAO announced the name of the Chairman (Dr. C. P. Idyll, U. S. A.) and the Vice-Chairmen (Prof. J. L. Cifuentes Lemus, Mexico; Dr. M. Fujinaga, Japan; and Dr. M. Massuti, Spain).

2.2 Adoption of the agenda

The Chairman submitted the provisional agenda for consideration by the Conference and it was unanimously adopted. He then summarized the discussions and decisions reached by the officers of the Conference regarding the procedure for presentation of papers to the Plenary Session, and stated that the names of the convenors and rapporteurs would be announced later.

Dr. M. Ruivo, Representative of the FAO Department of Fisheries, reviewed briefly the activities of the Department, as a background for proposals for action that might result from the Conference.

3. RESULTS OF THE CONFERENCE

It would have been presumptuous to expect the Conference to succeed in identifying and solving all the problems related to the study of the biology and culture of shrimps and prawns. This was well recognized at the outset by all those involved in organizing the Conference. It was generally felt that the technical discussions and the exchange

of ideas and views would clarify the problems confronting scientists and technicians. This would result in some new knowledge becoming available immediately and provide the basis for future lines of research and possible cooperation of a regional or international character, and also be of use for shrimp industry development. Based on these criteria, it is generally believed that the Conference has been successful. As very appropriately pointed out by the Chairman in his concluding remarks (Appendix 5), one of the chief benefits resulting from this Conference was the great improvement in personal understanding and communication between people engaged in this particular field.

In reviewing the present status of research in various parts of the world directed towards assessment of the complex life history of exploited species, the Conference recognized that many aspects are still not well understood and further studies are required. As present trends indicate greater demand for shrimp and prawn products in national and international trade, these studies should be intensified and accelerated. Although new shrimping grounds are being located every year, some important stocks have approached their peak of production. Evidently no improvement in the natural resources and protective measures for overfished stocks can be suggested unless some important ecological factors are fully understood.

Although the concept of shrimp and prawn farming on a large scale has been prevalent over a long period, the numerous impasses encountered, particularly in the initial rearing stages, discouraged continuation and new undertakings. The successful results achieved in Japan in this particular field were most stimulating and encouraging and could be considered as a breakthrough. Nonetheless many difficult problems have to be overcome before shrimps and prawns can be farmed at an economic level. Meanwhile the principal source of production will be the harvesting of wild stocks at sea.

3.1 Resource appraisal

The need to develop standards to appraise resource potential became evident from documentation presented and ensuing discussions. Although information on resource potential is required by the industry and FAO's Indicative World Plan for Agricultural Development (IWP), such knowledge is fragmentary at present. The consensus indicated no spectacular increases in production from many presently exploited grounds through improved fishing methods. The initial promising results of the electric trawl, which raised high expectations, have not yet been substantiated. Further research was found to be required in the development of echo-sounding equipment capable of detecting distinctly benthic and bathypelagic populations. The possibility was put forward of developing hypersensitive electronic techniques to discriminate between bioacoustic emissions of shrimp and other species, despite the limited advances in this field. The value was stressed of projecting abundance by assessing types of ecological habitats populated by various known groups of shrimp.

Though considerable attention had been paid to the study and exploitation of shrimp and prawn resources, the potentialities of unconventional species like the galatheid crabs or krill had been overlooked in the past. The utilization of untapped resources in various parts of the world provided an interesting discussion.

3.2 Life history

Despite numerous studies on the biology of species exploited over many years, and on which substantial fisheries are based, many aspects are yet to be explained adequately. Knowledge of life histories was considered scanty for relatively "unknown" species on which fisheries have recently been established. The Conference noted that lack of knowledge existed on development, transport and survival of larvae - thus seriously affecting understanding of fluctuations in recruitment. Similar gaps existed on the understanding of ecological factors influencing schooling, horizontal and vertical displacement, food preferences and predation, and also on growth and mortality

rates - two important parameters in understanding population dynamics. It was also noted that knowledge on the parasitology and diseases of shrimps and prawns was extremely limited, although such diseases affected quality and culture methods.

Numerous problems confronting research workers were discussed. Two ad hoc working parties were established to consider the need for further taxonomic research on commercial shrimp and the necessity of taxonomic identification of larvae and early postlarvae of shrimps and prawns.

The need was stressed for further information on larval abundance to assist in predicting future stocks. Estuarine pollution through disposal of mineral and chemical agents, and oil prospecting were considered as possible deleterious factors in larval and postlarval development.

Although not directly related to the subject under discussion, the utilization of incidental catches of fish and other animals made by shrimp vessels was raised. The return of "trash" fish to the sea was considered as assisting the biological cycle of nutrition. A partial solution to the problem from the economic view point was given by the development and installation of small fish-meal plants aboard Mexican vessels. Such plants could produce 8 tons of fish meal on a 15-day fishing trip.

3.3 Physiology and behaviour

Through study of the physiology of shrimps and prawns and other crustacean forms it has been possible partially to explain certain phases of exhibited behaviour.

Studies on osmoregulation have assisted in the understanding of tolerance to broad fluctuations in salinity. Salinity per se was not considered as the principal factor influencing displacement or production but instead the combined effect of salinity and temperature are thought to be important. Temperature has been considered as an important independent factor affecting production, through its influence on early and postlarval survival and by accelerating or decelerating the metabolic processes related to food intake and growth. Although analyses of observations made in temperate and sub-Arctic areas indicated an apparent relationship between increased catches and warmer ambient temperatures, in tropical and sub-tropical areas temperature appeared to be of less importance than salinity.

Where estuarine conditions are influenced by the outflow of large rivers (e. g. Mississippi), significant correlations between catches of Penaeus setiferus and rainfall have been found. Such correlations were not evident for other shrimp species nor in the lagoonal systems of southern Brasil, and further assessment of other possible factors being involved was required. The possibility was suggested of increased production after heavy precipitation being attributable to an increased food supply, resulting from run-off of land-based nutrient salts.

An understanding of the behaviour of inshore postlarval displacement during flood tide and offshore displacement of juveniles at ebb tide resulted from experimental work on Penaeus duorarum. A positive rheotaxis was exhibited at constant salinity but direction was reversed when salinity decreased.

In view of the small reserves stored in the bodies of shrimps and prawns, the importance of food supply to their reproduction, growth and migration was stressed. Lack of food could adversely influence oviposition, and availability of food could induce the emergence of one shrimp species (P. duorarum). Starved shrimps consume less oxygen than fed shrimps, a useful application in shrimp storage during transport.

In spite of studies which have provided an insight into the intricate and complex behaviour mechanism, many physiological aspects remain unsolved. Any knowledge elucidating the influence of environmental factors on physiological processes would improve capture

techniques and culture practices. More information is required on cannibalism, feeding efficiency and food preference.

3.4 Statistics of catch and effort

The appreciation that statistics are essential for resource assessment, government planning and business decisions stimulated an interesting discussion on the problems encountered in the collection of accurate statistical data and on the nature of data required to meet these multi-purpose uses. Although useful information could be obtained from the existing presentation of statistics, as provided by governmental and inter-governmental agencies and by FAO, further improvements were desirable and necessary. The need for better coverage, inclusion of more detailed data, and standardization of methods was stressed. An important point, also raised in another technical session, was the lack of definition in official landings of whether data refer to headless or heads-on shrimps and prawns.

Considering the importance and serviceability of statistical data to biologists, economists and industrialists engaged in this sphere of activity, it was suggested that an ad hoc working party be formed to consider the pertinent problems discussed. There was general agreement that FAO should assume a leading role in promoting the accurate compilation of statistical data.

3.5 Stock assessment

As the world shrimp and prawn fisheries expand, so does the requisite for further knowledge on stock assessment. An expanding fishing industry requires in particular that scientists predict size and composition of stocks subjected to exploitation, and determine the maximum sustainable yield.

Although some progress had been made in the studies related to shrimp and prawn population dynamics, further research was required in the development of new methods and models designed to provide an estimation of stock size and density. Because the life span of the majority of exploitable shrimp and prawn species is short, methods applied to the dynamics of teleost fish populations may require adaptation. When the life span is relatively short, the effect of fluctuating environmental conditions on recruitment, growth and natural mortality - important parameters in the discipline of population dynamics - is more pronounced, thus making predictions on relative abundance on fishing grounds difficult. When life span is longer, as in Pandalids, prediction estimates are made easier through appraisal of the possible effect on recruitment by the prevailing environmental conditions during and following hatching.

The documents presented at the Conference revealed the variability of approaches to stock assessment. These included appraisal of environmental and ecological factors influencing recruitment, growth, displacement and natural mortality; calculations of mortality rates by use of predators; studies on growth rates from shift in modal sizes; quantitative surveys of larvae, postlarvae and juveniles in order to estimate pre-recruitment survival or to forecast relative abundance on the fishing grounds. Though each approach was considered functional, the desirability of employing more than one approach was stressed. All approaches required further understanding of the environmental and ecological factors involved and accurate data of catch composition and catch/fishing effort.

3.6 Culture of shrimps and prawns

The recent increased interest in aquiculture by academic, industrial and private sectors led to considerable discussion following the review of the status of pond and artificial culture of shrimps and prawns.

3.6.1 Pond culture

Although pond culture has been pursued over a long period of time, particularly in Southeast Asia, studies based on scientific discipline and aimed at assessing possible factors influencing production are relatively recent. These studies were also considered to be mainly biologically oriented and it was recognized that more emphasis is required on the physical-chemical conditions in ponds. Any knowledge obtained would assist in improving existing empirical methods. The necessity was stressed of further work on tropho-dynamics and on mortality, particularly caused by cannibalism. Although interest in capital investment in pond culture was considerable, the necessity was pointed out of detailed information on the yields and economics, as compared with actual fishing operations in the same region. It was felt that an adequate understanding of the prerequisites in pond culture techniques would undoubtedly assist in the introduction and development of such practices in other suitable areas of the world, for example in Central America and Central West Africa.

The importance of safeguarding estuaries and inland waters from pollution, a major threat to the survival of existing shellfish fisheries in industrial countries, was not overlooked by the Conference. It was recommended that this important problem be brought to the attention of the forthcoming FAO Conference on Marine Pollution and its Effects on Fishery Resources and Fishing.

3.6.2 Artificial culture

At present shrimp and prawn farming on a commercial scale has been achieved only in Japan, Malaysia and Korea. Although considerable progress has been made in the United Kingdom in rearing Palaemon serratus, problems related to pond preference, cannibalism and disease have not been solved. Similar impasses with rearing experiments on commercially important species have been reported from North American and European research institutions and private enterprises. Possible factors contributing to failures of artificial culture were considered and suggestions were made for overcoming difficulties encountered, based on individual observations and experiments.

It was reported that spawning could be activated by increasing pH. Abundant food required by larvae kept in large open tanks could be provided more easily by filtering coastal water than by culturing plant food separately. Postlarval cannibalism can be reduced if an ample supply of Artemia nauplii is added to the mysis stage. Japanese experiments indicated higher juvenile survival if food consisted of mixed components rather than solely of fish, because shrimps are reportedly unable to digest vertebrate food unless the temperature is high. Other experiments in Japan showed shrimp preference for animal food (clams) free from haemoglobin.

Since past and present attempts have been mainly oriented towards rearing species with numerous and prolonged stages of larval development, the difficulties in providing optimum food and environmental conditions at each stage have been increased. Consideration was therefore given to the rearing of species with direct or abbreviated development. Reference was made to species exhibiting such biological aspects.

The possibility was suggested of experimenting with encapsulated foods specifically flavoured to diminish cannibalism, or of inducing sex change at the appropriate stage through the incorporation of chemicals or hormones. In view of the limited knowledge on food preference and food efficiency - apparently of paramount importance to larval survival and growth - it was recommended that more research be undertaken on this topic.

3.7 Standardization of research methods

Since this theme had not been considered by the Consultative Group at the outset as one of the main objectives of the Conference, so that it did not appear as a principal agenda item, the number of technical documents directly related to methodology on

shrimp and prawn research methods was relatively small. Nevertheless, many authors referred to methods pursued, occasionally with suggestions for their improvement, in accounts of the collection of biological and oceanographical data during exploratory surveys, of larval and postlarval sampling, size and weight measurements, maturity and fecundity determination, data analysis by computers and rearing techniques.

Although in some geographical areas inter-governmental agencies or regional bodies have given consideration to the importance of method standardization on shrimp and prawn research and have accordingly adopted some resolutions proposed (e. g. ICES' adoption of carapace length as a standard measurement in decapod crustaceans), no further progress has been achieved for the promotion and adoption of other methodological procedures on a wider scale or at an international level. The usefulness of method standardization for comparing and evaluating results obtained from different parts of the world was unquestionable. It was recognized, however, that some particular problems, i.e. sampling frequency, number of individuals per sample, size and weight measurements and data grouping, required further study before proposals for their regional or universal adoption were made.

3.8 Recommendations

The Conference considered the suggestions and proposals made by the technical sessions for filling the gaps of knowledge now existing in all aspects of the subject matter. These recommendations are listed under the reports of the respective technical sessions (Part 4). The Conference also approved the following recommendation:

Regional cooperation for the study of shrimp resources

Whereas international cooperation is required in order to make more effective the rational exploitation and conservation of marine resources in a given area; and

Considering that this cooperation in studies of marine species populations exploited by various countries makes necessary the exchange of knowledge obtained through fishing and biological research activities, in order to have required basic information; and

Being aware that international cooperation permits a better utilization of human resources, ships and other facilities indispensable for implementing programs of common interest;

The Conference recommends:

That closer attention be paid to cooperative studies of shrimp resources, and to use for this purpose, whenever possible, existing regional committees; and if there are no such committees, to utilize temporary or ad hoc arrangements with this same objective.

Considering that there are in the Caribbean area several national institutions and programs under the United Nations Development Program that have important projects devoted to the study of shrimp resources, it is recommended to FAO to explore the possibility of adoption of pertinent measures to facilitate such regional cooperation.

4. REPORTS OF TECHNICAL SESSIONS AND AD HOC WORKING PARTIES

4.1 Resource appraisal

Convenor:	M. J. Lindner
Rapporteur:	J. H. Kutkuhn
Documentation:	E/1, 8, 23, 24, 27, 29, 38, 39, 41, 50, 67, 69 R/3, 5 RS/1

Two main topics were dealt with in this session: Resource Appraisal and Appraisal Methods.

Under the first, the Conference reviewed reports of new knowledge on the status, size, distribution and potential of world shrimp stocks; under the latter, reports and discussions on new techniques employed in exploratory fishing and in projecting yields. A summary of the information available from the submitted documents follows. Papers were not submitted on some areas, therefore many regions are not mentioned in the following summary:

North Atlantic The Greenland fishery based on Pandalus borealis is not yet fully exploited. Fluctuations in production are attributable to marked environmental thermal changes. Fishing pressure on undersized shrimps could be alleviated by encouraging fishing operations in deeper water where larger specimens predominate. According to one opinion future annual production was not expected to exceed 6,000 tons.

Central Atlantic Results of exploratory surveys made off the southeast coast of Cuba demonstrated that catches of Penaeus duorarum and P. schmitti were lower from unexploited areas than those intensively harvested. Although possibilities for appreciable expansion appeared to be negligible, construction of new specially designed vessels is being carried out.

The rapid development of the inshore bait fishery in Florida, based on small-sized P. duorarum, was discussed and it was conjectured that heavy demands on undersized shrimp could result in less shrimp reaching the traditional offshore fishing grounds.

South Atlantic The decline of the Penaeus schmitti and P. duorarum fishery in Venezuela during 1966 was believed to be related more to natural fluctuations in abundance than to overfishing. There is great concern regarding the probable effect on the resource of the proposed restrictions at the mouth of Lake Maracaibo to prevent further intrusion of seawater, and to correct sedimentation problems. Fears were expressed that such restrictions could inhibit movement of young shrimp into nursery areas.

The waters of northeastern Brazil may not be rich in shrimp resources, although good concentrations of Penaeus aztecus were detected off northern Brazil (Lat 1° to 3° N, Long 48° to 49° W), at depths between 36 and 73 m. The density of the mantis shrimp, Squilla lijdingi, was a useful indicator of the presence of commercial shrimps.

An appraisal of shrimp resources, mainly penaeids, in the eastern Atlantic from Spain to Senegal showed that yields have increased significantly during the past 25 years. Catches in the region have generally stabilized although overfishing is suspected on the Spanish and Balearic continental platform. Increased landings can be expected if more attention is paid to species occurring in deep water (200 to 1,000 m).

North Pacific Prospects for greater yields from Pandalus and Pandalopsis resources in British Columbia are considered good. Production is expected to increase from 750 to 1,200 tons over the next 10 years.

Central Pacific The potential of the red crab resource (Pleuroncodes planipes) in the eastern central Pacific was rated as very good and a possible production of 30,000 to 300,000 tons per year was postulated; but the usefulness of these figures and the manner of their projection was questioned. From this discussion arose the opinion that standards for appraising resource potential from available data should be developed, taking into consideration the acceptable level of production per unit effort, differential size of vessels generating abundance data, etc.

South Pacific A small fishery based on two Penaeus species in Shark Bay, Western Australia, was not expected to produce more than 92,000 tons by 1975.

Indo-Pacific Shrimp and prawn resources in this important region were dealt with in two papers, one describing resources in India and the other summarizing existing knowledge on resource distribution, and capture and culture methods practised in the Indo-Pacific Fisheries Council region. No estimation of future production was attempted, but according to one paper Indian resources are not overfished and rational increases in their exploration are possible. It was suggested that the unutilized extensive estuarine and brackish areas in India be converted and adapted to prawn and fish culture.

4.1.1 Appraisal methods

Various opinions were expressed on the type of data required for the establishment of resource potential through exploratory surveys. The required information and phases to be followed, as presented in one paper, were considered by some as too sophisticated and unrealistic for many areas. The importance of the contrast of efficiency between survey and commercial fishing vessels was not overlooked. It was generally accepted that the latter outfish the former because skippers tend to concentrate their efforts in areas where the species being evaluated appears to be most abundant. The value was stressed of charts depicting types of bottom, location of nursery areas, etc. as aids to both fishermen and biologists in locating and appraising shrimp resources inhabiting specific regions.

Progress on the development of electric shrimp trawls and unresolved problems, particularly related to the differential conductivity of substrates, created useful discussion. Although promising results have been achieved, the gear was not considered sufficiently advanced for general use. Calcareous sediments appeared to retard the penetration of the electrical field and thus reduce its efficiency. At present electric trawls are not available commercially, though the cost of parts required for the system is approximately US$ 500.

The desirability of employing improved fishing techniques was unquestionable. Nevertheless, fears were expressed that the employment of more efficient gears without restraint might accelerate the demise of important shrimp fisheries. The Conference hoped that proper guidelines for managing shrimp resources and the fullest use of shrimp gear efficiency would develop in such a manner that conflicts, which otherwise could occur if gear efficiency outpaced the necessary fishery regulations, would be obviated.

In a review on shrimp detection and fishing techniques employed in principal producing areas, the author emphasized the importance of intensified research on shrimp behaviour in relation to their catchability. It was recognized that advances in shrimp detection by echo sounding had not achieved the same progress as that of fish; nevertheless, Japanese shrimp fisheries rely heavily on this method, particularly as applied to the mid-water trawling for Penaeus orientalis in the Yellow Sea and East China Sea. Shrimp detection by echo sounding required two types of apparatus - a high-frequency

equipment to depict the fine detail of benthic and bathypelagic populations, and a medium-frequency instrument to unravel large organisms of interest - or a dual-frequency sounder of high power. Some scepticism was expressed whether echograms could actually depict commercial shrimp concentrations.

The possibility was examined of developing electronic techniques capable of differentiating between bioacoustic emissions of shrimp resources on the bottom. It was conceded that such hyper-sensitive equipment had not yet been developed.

4.1.2 Recommendation

The Conference recommended that FAO establish a working party to consider the development of methodology and standards for appraising crustacean resources, with particular reference to:

(i) Determining an acceptable level of future production per unit of effort in the country

(ii) Intercalibrating different forms of fishing effort

(iii) Making an inventory of the world's shrimp resources by assessing the types of ecological habitat in which various groups of shrimps are most likely to occur, and then projecting abundance with a suitable factor

4.2 Life history

Convenor: K. F. W. Tiews

Rapporteur: J. J. Ewald

Documentation: E/6, 10, 13, 16, 17, 20, 22, 28, 30, 36, 37, 38, 40, 43, 47, 50, 52, 53, 62, 64, 65, 66, 68

R/1

SS/1 to 11

INF/2

Taxonomy and distribution Information on the taxonomy and distribution of the most important exploited species of shrimps and prawns belonging to the Genera Crangon, Pandalus, Penaeus, Metapenaeus and Macrobrachium was provided by species synopses or experience papers, some documents dealing only with morphological and identification aspects of larval, postlarval and mature stages. The world-wide distribution of commercial shrimps and prawns was presented in INF/2.

Serious gaps were revealed in the state of knowledge regarding pandalid distribution, and differences of opinion were expressed on the taxonomic status of Penaeus duorarum found in West Africa, and of Metapenaeus affinis reported from India. The need for further research on (a) the taxonomy of shrimps and prawns of commercial value and (b) taxonomy and identification of larvae and early postlarvae, led to the establishment of two ad hoc working parties to deal with the specific problems raised.

Development, transport and survival of larvae The dissimilarity in the number of free larval stages in the life cycle of various species of shrimps and prawns is considerable, varying from none, as in Sclerocrangon boreas, to 15, as in some species of Penaeus. The number of stages for a given species can vary when reared under different experimental temperature conditions. Pandalus montagui showed eleven zoeal stages at 10°C and only five at 18°C. Because of the effect this may have on the duration of planktonic life and hence on the distribution of the species, the need for further studies was stressed.

In view of the importance of larval distribution in the assessment of spawning stocks, the Conference considered that more attention should be paid to larval surveys, and indicated the benefits which could result from closer international cooperation in these studies, particularly in the fields of gear and methodology.

Quantitative data are non-existent on larval survival for most shrimp species, and factors influencing survival rates, such as predation, food supply, sudden changes in hydrographic conditions and molting, have hardly been determined. Research is urgently required on food requirements at different larval stages, availability of the respective food items, and resistance of larval stages to environmental changes. The usefulness of such studies has been demonstrated in south Florida where it has been calculated that the annual production of first protozoea of Penaeus duorarum was approximately 87×10^{11}, with a daily survival rate of 84 percent, thus yielding about 85×10^{8} postlarvae available to enter the inshore nursery areas.

Larval mortality under laboratory conditions is variable and depends on the initial stocking rate and the amount of food available. In most experiments the estimated survival rate from nauplius I to first postlarvae has been approximately 50 percent. The desirability of standardization on larval collection techniques with regard to regions or groups of species is evident.

Ecology of juveniles The ecology of juveniles of shallow-water shrimps is better understood than that of the deep-sea shrimps. Postlarval stages of Crangon crangon are benthic, their distribution during the summer being similar to that of adults, while penaeid postlarvae are pelagic. One paper suggested that differences in salinity appear to have no effect on the abundance of penaeid postlarval forms, while temperatures exert a significant effect.

Information on the ecology of juveniles is urgently needed to understand the population dynamics of shrimps and prawns. There has been considerable progress in research in this field but gaps of knowledge in many areas need to be closed.

Life span As reported in various papers, Penaeus species appear to have the shortest life span (1 to 2 years) and Pandalus species the longest (3 to 7 years). The life span of C. crangon is 3 to 4 years.

Schooling While information is available on schooling behaviour of some shallow-water demersal shrimps and prawns, there is an acute lack of knowledge with respect to bathypelagic forms. In view of the potential commercial importance of these species, attention was drawn to the need of research on their schooling behaviour.

Schools may consist of individuals of all sizes and ages, as in Pandalus jordani, or of individuals of approximately the same length or age, as in Penaeus spp. Often only one school is encountered on the fishing ground, as observed in catches of P. jordani, and in such cases the catch of other animals is minimal. The distribution pattern of the school is forever changing in size and shape, possibly due to environmental influences. It has been shown that light itensity affects the schooling behaviour of C. crangon.

Migration of adults A considerable variety of migratory movements is exhibited by shrimps and prawns in response to maturity, spawning, feeding and environmental stimuli, particularly temperature, salinity and light intensity.

Pandalus montagui migrates onshore in spring and offshore in autumn, while C. crangon exhibits feeding and spawning migrations. At the beginning of March, C. crangon migrate onshore to feeding grounds encountered in brackish waters, and from May to July large concentrations of ovigerous females migrate offshore but return close to the coast after hatching. By October a displacement occurs to the deeper and more saline waters.

Young Penaeus setiferus move out of the estuaries where they have entered as postlarvae and have grown in the less saline waters. Movement out of the estuaries appears to be associated with stage of maturity and with temperature. In the sea, movements vary with size, locality and season. In some areas shrimp displacement is parallel to the coast and does not extend into deeper waters. In other areas the only definite pattern is offshore and onshore movements. The longest migration recorded for this species was 360 miles (667 km), the period of liberty being 95 days.

P. schmitti exhibits a similar pattern of inshore and offshore movement during its life cycle. Local movements are attributed to search for food, protection and to external stimuli, such as temperature, light intensity and water movements.

Most penaeid shrimps on the southwest coast of India move out into the deepest zone from February to March onwards, and return to the shallower fishing grounds by September. The movement into deeper waters has been related to upwelling which occurs during the monsoon. Metapenaeus dobsoni seems to exhibit movement in the opposite direction. The two types of movements exhibited by Solenocera indica are related to spawning and salinity influence. The daily vertical migrations of Pandalus borealis and of other pandalids are associated with light intensity. The off-the-bottom movement occurs only in darkness and duration is related to the length period of darkness.

In summary, despite the small number of marking experiments on shrimp, the results obtained are noteworthy. For fuller understanding of migrations and their population identification, an intensification of marking experiments is highly recommended. The use of magnetic tags for activity studies was suggested.

Parasites No parasites have been detected on C. crangon, but P. montagui is parasitized by the bopyrid isopod Hemiarthrus abdominalis, and an unidentified bopyrid isopod has been recorded from Metapenaeus dobsoni. Of the eight parasites recorded from P. setiferus only those belonging to Cnidosporidia can affect quality, while the others appear to be harmless to human beings. A microsporidian appears to be responsible for the "black spot" disease in P. schmitti.

Although indications exist of increased mortality rates through parasitical infection, particularly in culture practices, its importance has been underrated and it was suggested that further research be undertaken in this particular field.

Predators All shrimp and prawn species seem to be heavily preyed upon by a large number of aquatic animals, including their own species. For a better understanding of population dynamics, knowledge of predation rates appears to be indispensable. The annual loss to the C. crangon stocks along the German North Sea coast during a ten-year period due to predation has been calculated to be 145 billion shrimps, predation being 1.7 to 4.3 times higher than the fishery.

In view of the great significance in assessing the quantitative loss of shrimp stock through predation, considered as the most important factor of natural mortality, research in this field is strongly recommended.

Sex change No sex change has been reported in penaeid shrimps, but it is exhibited by many pandalids. The percent of protandric hermaphrodites in pandalids may vary within and among species. In P. montagui the percentage of primary females can be as high as 50, while in P. montagui tridens and P. platyceros no primary females have been observed. Evidence was offered that pandalid populations in Alaska comprise primary females.

Sex change is not related to age and varies from species to species. In P. montagui males become secondary females at an age between 1 and 1½ years, in P. jordani between 2 and 3 years, in P. platyceros at 2½ years, while in P. borealis the period varies from region to region: 2½ years in southern Norwegian waters, 4 to 5 in Greenland and Gulf of Alaska, and 5 in the far northern waters of Norway.

The recent suggestion of C. crangon exhibiting sex change is questionable since no transitional stages have been observed in secondary male sexual characters (first and second pair of pleopods) and German laboratory breeding experiments have not confirmed the change.

4.2.1 Recommendations

The Conference recommended that:

4.2.1.1 A few major institutions with adequate manpower and equipment be selected to act as depositories for specimens and reference collections to facilitate the examination of material on a world-wide basis. The cooperation of institutions and organizations interested in shrimp and prawn research should be sought.

4.2.1.2 A working party be established by FAO to prepare a selected bibliography on the identification of commercial shrimps; and to revise and, if necessary, expand INF/2, "List of species of shrimps and prawns of economic value", paying special attention to the checking of distribution areas, scientific nomenclature and synonyms, vernacular names and the vertical distribution range of species listed. Dr. L. B. Holthuis was proposed as the Convenor

4.2.1.3 Studies be made on the characteristics and performance of gear used at present for the quantitative collection of larvae and postlarvae, as well as the standardization of methods to permit comparison of results. This problem should be brought to the attention of the Scientific Committee for Oceanic Research (SCOR) for consideration by its working parties dealing with the standardization of plankton methods

4.2.1.4 The attention of research workers be drawn to the need for studying the following aspects of life history:

(i) Ecology of juveniles

(ii) Schooling behaviour of shrimps, especially bentho-pelagic

(iii) Marking experiments

(iv) Parasitic infection and diseases

(v) Quantitative assessment of loss of shrimp and prawn stocks through predation

4.2.1.5 Research be coordinated in promoting the collection and compilation of data, the standardization and intercalibration of methods and equipment, to facilitate the exchange of information and experts between laboratories

The Conference requested the Director-General of FAO to take steps to implement these recommendations and suggested that his Advisory Committee on Marine Resources Research (ACMRR) be asked to study ways and means of doing so.

4.2.2 Ad hoc Working Party on the Taxonomy and Identification of Larvae and Early Postlarvae of Shrimps and Prawns

Convenor: S. Dobkin [2/]

Recommendations

4.2.2.1 That the Working Party should undertake an updating of Guerney's Bibliography of the Larvae of Decapod Crustacea, as it concerns shrimps and prawns, such revision to include all members of Natantia and thus provide literature for comparison of commercially important species with others in the same area.

2/ See Appendix 1 for members of the Working Party

4.2.2.2 That the Working Party undertake the compilation of a list of specialists on taxonomy and identification of larvae and early postlarvae of shrimps and prawns who might be willing to examine material sent to them

4.2.2.3 That selected specialists be requested to prepare regional illustrated keys and atlases to the larvae and early postlarvae of shrimps and prawns; and that FAO be requested to investigate means of financing this work

4.2.2.4 That the Working Party continue in existence, under the guidance of the Marine Biology and Environment Branch of the FAO Fishery Resources and Exploitation Division, until accomplishment of its presently assigned task. In addition to its present membership, D. I. Williamson (United Kingdom) and D. F. Makarov (U.S.S.R.) should be asked to serve on the Working Party

4.2.2.5 That participants in the Conference to be asked to contact workers on Natantia larvae and early postlarvae in their own countries and ask them to send to the Convenor of the Working Party reprints and literature citations of their scientific contributions from 1962 onwards

4.2.3 Ad hoc Working Party on the List of Species of Shrimps and Prawns of Economic Value

Convenor: L. B. Holthuis 3/

Recommendations

4.2.3.1 The following recommendations for the improvement of INF/2, "List of species of shrimps and prawns of economic value" by L. B. Holthuis and H. Rosa, were made:

(i) The title should be changed to "List of species of shrimps and prawns of commercial value" so its scope is more precisely indicated

(ii) The paper should be provided with an introduction describing its scope and purpose, explaining the diversity in the usage of the terms "shrimps" and "prawns" without, however, attempting to standardize these terms

(iii) The tabular approach should be replaced by short paragraphs for each species; the method of indicating land and water areas by code replaced by a short description of the range of natural distribution; and the areas where the species are cultured indicated separately. The code could however be retained additionally for computer purposes

3/ See Appendix 1 for members of the Working Party

(iv) Only those species which constitute substantive landings should be included in the list, but if it is considered advisable to include other species these should be printed in a distinctive type

(v) Nomenclature should follow strictly the existing International Code of Zoological Nomenclature. Disputes on purely nomenclatural grounds should be submitted to the International Commission on Zoological Nomenclature, but for differences of opinion on taxonomic grounds the Working Party should accept the solution it thinks best, indicating the existence of other viewpoints

(vi) The following information should be given for each species:

(a) the more important synonyms

(b) vernacular names, with indication of the language and area where applied

(c) land and water areas inhabited (see iii)

(d) maximum size, both total length (including rostrum and telson) and carapace length (from post-orbital margin to mid-dorsal point of the posterior margin of the carapace)

(e) nature of sea bottom preferred

(f) depth range, both total known range and that of exploited area

(g) whether marine, brackish or freshwater

(vii) The bibliography should be considerably extended but at the same time restricted to taxonomic treatises, particularly those containing keys to genera and species

(viii) There should be two indexes:

(a) listing by taxonomic groups and geographical regions

(b) generic and specific names, including synonyms

The Working Party also recommended that:

4.2.3.2 Dr. L.B. Holthuis (Netherlands) should undertake the revision of INF/2, in collaboration with the other members of the Working Party and with FAO

4.2.3.3 The questionnaire, reproduced on page 19, be circulated by FAO to its regional fishery officers for further distribution in their region; if possible, questionnaires should be returned with a sample for identity verification

4.2.3.4 A list of shrimp and prawn taxonomy specialists who would be willing to undertake identifications should be prepared for the purpose of assisting field workers; it should indicate taxonomic groups and geographic areas from which the specialists are prepared to accept material

4.2.3.5 The preparation of two additional types of publications:

(a) Lists along the lines of those proposed above, but complete with keys and illustrations to all species noted

(b) Simple, illustrated loose-leaf pocket books for the use of market officers and other concerned in the collection of statistics. Only those species likely to be encountered by the officer concerned would be included in the book issued to him but major laboratories in his country would have a complete set of all issued pages

The possibility of their publication under the auspices of FAO should be examined.

QUESTIONNAIRE RELATING TO PRAWNS AND SHRIMPS OF COMMERCIAL IMPORTANCE

(one form to be used for each species)

1. Scientific name of species:

2. Source of identification:
(handbook, key, etc.)

3. Vernacular name(s):
(indicate with each name its language or dialect; if the name is used in a restricted area, this area should be indicated)

4. Whether cultured or natural populations:

5. Geographic area(s) where the species is caught:
(list separately for cultured and natural-occurring populations)

6. Depth range where caught:

7. Maximum size:
(indicate which length used: (i) carapace length [posterior margin of orbit to mid-posterior point of carapace] or (ii) total length [including rostrum and telson], or, preferably, both)

8. Nature of bottom where species is found:

9. Salinity of the water:
(the indications fresh, brackish or marine are sufficient, more accurate indications are welcome)

10. Commercial importance:
(check one of the following): ☐ major ☐ medium ☐ minor

11. Usage:
(indicate whether (a) for food, (b) for bait, or (c) otherwise (specify). For (a) indicate whether (i) as such, or (ii) for preparation of meal, cakes, paste, sauces, etc. (specify which); (iii) whether whole or peeled; (iv) whether fresh, cooked, dried, fried, etc.)

12. Accurate locality, date of capture, collector and other details of sample sent with this list:

4.3 Physiology and behaviour

Convenor: H. Schafer

Rapporteur: A. B. Williams

Documentation: E/3, 4, 5, 14, 15, 25, 32, 33, 48 49, 55, 56, 58, 59

In brackish waters marine animals are compelled to counteract the dilution of their body fluids by active processes. The degree of osmoregulation which animals can maintain is an index of their salinity tolerance. Estuarine and coastal shrimp and prawns display differences in their osmotic behaviour, particularly in relation to their points of isotonicity, but in general they tend to be hypotonic in sea water and hypertonic under estuarine conditions. The metabolic processes and the activities of shrimp and prawn depend to a great extent on the temperature of their environment; low temperatures depress these functions while higher temperatures accelerate them. Although post-larval and juvenile penaeids are fairly tolerant to a wide range of salinity and temperature, adult penaeids are generally intolerant to low salinities and temperatures.

Osmoregulation At temperatures of 8.7° to 8.8°C the osmoregulatory activities of Penaeus aztecus and P. duorarum are impaired, and their blood becomes isotonic. The blood osmotic pressure of Palaemon serratus increases with a reduction in temperature under constant salinity. C. crangon moves to higher salinities at low temperatures. Many temperate marine species tend to be represented by brackish and freshwater counterparts in the tropics. Culture of prawns is easiest above 15°C.

The foregoing appears to indicate that at low temperatures metabolic processes become too slow for efficient osmoregulation, but at higher temperatures it is operative enough to allow animals enter less saline waters.

Temperature Temperature appears to influence growth. At temperatures between 15° and 25°C, P. setiferus showed a constant growth rate increase; between 25° and 32.5°C the rate remained constant, but between 32.5° and 35°C a decrease occurred. P. aztecus exhibited a rapid increase in growth rate from 15° to 20°C, slower increases from 20° to 25°C, and no increase from 25° to 32.5°C. At 35°C the rate declined and no animals survived these temperatures for more than 11 days. The period of acclimatization is very important for survival.

It has been postulated that application of knowledge of optimum conditions for a particular shrimp, as determined in the laboratory, could assist in locating new resources. An apparent relationship between increased catches and warmer ambient temperatures has been detected from studies on P. setiferus, P. duorarum and P. aztecus catches made from North Carolina to Texas.

C. crangon catches per unit of effort along the German North Sea coast are higher during warm summers, but this is partly dependent upon stock size. Alternatively, it has been observed in the Gulf of Tehuantepec, Mexico, that no correlation between temperature and catches is evident except for an aberrant year in which catches were higher with cool temperatures. In addition, a good correlation has been observed between increased catches and temperature decrease produced by upwelling.

In tropical and subtropical areas catches are affected less by temperature than by salinity, except when high temperature is associated with low oxygen water content.

A comparison of Pandalus borealis populations occurring in Newfoundland waters between 4° to 6°C and 0°C showed that the first contained larger sized individuals, a higher percentage of females, all spawning annually, while the latter comprised smaller

individuals, few females and annual spawning was less than 65 percent. Evidently in cold waters males reach their growth limit before they become females. On the basis of this study, recommendations for future fishing activities in the area were made.

In Skagerrak waters, temperature decreases of 2°C have resulted in a 50 percent catch reduction. In Alaska colder than normal winters may send P. borealis populations into deeper waters. When temperatures are not near limiting extremes, shrimps and prawns appear to be free to move within their salinity limitations.

Salinity Under experimental conditions juvenile Penaeus duorarum exhibit a strong positive rheotaxis at constant salinity, but direction is reversed with a salinity decrease of 2°/oo/20 min. Postlarvae do not swim against strong currents, but a salinity reduction results in decreased activity and settling of the organisms on the bottom. A salinity increase reverses this motion. Such behaviour may explain the inshore displacement of postlarvae during flood tide and the offshore displacement of juveniles at ebb tide. Isolated changes, such as a salinity decrease from 60 to less than 10 °/oo in an Ecuadorian lagoon, have not resulted in emigration of juveniles from the affected area. It is suggested that responses among juvenile shrimp are usually the result of rate of change than absolute variations in salinity. The effect of other environmental influences on rheotactic responses requires further research.

Although significant correlations between catches of Penaeus setiferus and rainfall during the two previous years have been found in Texas, no such relationship has been observed for P. aztecus. It was felt that relationship between shrimp catch, temperature and river runoff should be assessed. Increases in catch, both in lagoonal systems and in certain shallow sea-water areas following storms, may be the result of increased food supply.

Results of studies near Galveston Bay indicated that sharp water temperature decreases appear to stimulate emigration of P. setiferus, and it is believed that temperature is the deciding influencing factor here.

Food supply Growth, reproduction and migrations are all dependent on food supply. The presence of abundant food stimulates continued growth of the reproductive gland of female C. crangon, permitting oviposition after each moult. With suboptimal food supply oviposition did not occur after each moult.

Shrimps do not store large amounts of reserves in their bodies. During an 11-day starvation period the fat content of the hepatopancreas of P. duorarum decreased from 52 to 8 percent. The glycogen content of the hepatopancreas also decreased, but at a much slower rate. The protein content, as expressed by total nitrogen, remained constant, but gland size declined from 38mg/g of body weight to 22mg/g after 7-day starvation. Of the reserve materials available to starved shrimps, the fat, protein and glycogen content is 85.8, 14.07 and 0.12 percent respectively. The rapid decline of fat content indicates that these stores will disappear in a relatively short time.

It was suggested that dense populations of shrimp are unlikely to be maintained by masses of large food particles, and that the epifauna and epiflora of mud substrata contribute to a large extent to the nutrition of these populations. Some species show food preferences, and feeding habits change with size. Shrimp held in ponds under conditions of constant salinity, temperature and food supply show greatly accelerated growth upon release. Some fluctuations in population size might be due also to changes in environmental factors affecting food supply.

Food supply affects the emergence of P. duorarum from the bottom. The emergence cycle in this species obeys a 24-hour feeding rhythm as well as a dark-light cycle. P. duorarum burrows into the substratum during periods of light and emerges at the onset of darkness, but food prompted its emergence during light periods.

Oxygen Penaeus indicus and P. semisulcatus consume less oxygen during starvation than when fed. Oxygen consumption was reduced by 32 and 57 percent respectively after one-day and two-day starvation periods. Starved shrimp also survived longer than fed shrimp in water containing the same amount of oxygen, a useful application in shrimp storage. P. schmitti survives longer out of sea water at low temperatures, and oxygen consumption in this species shows a direct relationship to body weight.

Moulting The moulting cycle alters the metabolic processes of shrimps and prawns and may obscure changes originated by other factors. The microscopic examination of endopodite setae of pleopods shows discernible changes in the internal structure which permits identification of early post-moult and inter-moult in P. duorarum.

General Although some aspects of physiology and behaviour of shrimps and prawns have been observed, there are large lacunae requiring investigation. Knowledge of shrimp responses to certain stimuli, and of their physiological processes, would be useful in elucidating their migrations, growth, mortality and reproduction, and for devising better methods of capture. A thorough understanding of the environmental factors affecting the physiological process would also permit cultural practices. This knowledge would also improve catch prediction.

Certain environmental factors such as rainfall and air temperature are at present beyond human control; nevertheless, man is often able to alter the environment to his purposes. Unfortunately in most cases these changes have been detrimental to the shrimp and prawn fisheries; estuaries have been polluted, access channels closed, substrata altered by dredging, and freshwater supplies blocked by drainage operations. These trends could be reversed, however, and efforts made to modify the environmental conditions in estuaries and coastal lagoons, thus improving shrimp and prawn survival and growth during some stages of their life cycle.

4.3.1 Recommendation

The Conference recommended that:

To rectify the present gaps in knowledge of physiology and behaviour, the attention of research workers should be drawn to the following subjects requiring particular study:

(i) Tolerance limits for physical environmental factors at different ages among shrimps

(ii) Assessment of the combined effect of environmental factors on shrimp populations

(iii) Clarification of the meaning of the terms "postlarvae", "juvenile", "sub-adult", etc.

(iv) Reasons for cannibalism among captive or cultured populations

(v) Feeding efficiency and food preferences

4.4 Statistics of catch and effort

Convenor:	J. L. Obarrio
Rapporteur:	R. W. Ellis
Documentation:	E/6, 9, 12, 19, 46, 54, 57, 61
	INF/1

The purpose of this session was to discuss and define standardization, compilation and quality of shrimp and prawn data.

As shrimp and prawn fisheries expand, so does the requirement for statistics by governments, industrialists, economists and fishery biologists. The data required include total catch and value by species, sizes of shrimp caught, fishing effort, units of effort, landing ports and fishing areas. Its acquisition in some instances necessitates the utilization of log books on vessels and interviews with vessel captains.

The methods applied to data collection and the problems encountered were outlined in the papers discussed by the Conference. The principal problems considered were:

(i) Accuracy and authenticity of data

(ii) Fishermen's reluctance to reveal catch data (for fear of taxation) and area of catch, especially when new grounds have been located

(iii) Difficulty in obtaining complete coverage, particularly when a coastline is extensive

(iv) Difficulty in accurate compilation by species, due to the usage of different common names for identical species in different areas

(v) Conversion factors

(vi) Establishment of ex-vessel catch value

Methods for handling, processing, storing and rapid availability for analysis of voluminous data through electronic computers were described, and the following suggestions for improving present-day statistics were made:

(i) Standardization of collection and presentation, to facilitate data comparison and to increase their use by research workers

(ii) Grouping of species into categories

(iii) Determination of shrimp and prawn catches by foreign-based vessels when fishing in offshore areas of other countries

(iv) Establishment of a list of common and scientific names to be applied in the presentation of statistics, first on a regional and later on a universal basis, to eliminate confusion in statistical classification

(v) Differentiation in official statistics between headless or heads-on shrimps and prawns

(vi) Improvement of data collection on quantities discarded at sea

(vii) Inclusion of the value of catches, because of its importance in economic studies and for making business decisions

The discussion revealed that the majority of commercial and economic data are collected by census methods and that very little research has been carried out on collection by stratified sampling. The Conference agreed that more research is required to develop methods of collecting business and economic shrimp statistics by utilizing stratified sampling techniques to reduce the cost of collection and to improve the currency of the data.

4.4.1 It was considered that an ad hoc Working Party on Fishery Statistics (Crustacea), with Mr. G. G. Snow as Convenor 4/, should be established to deal with the problems raised. The following recommendations were endorsed by the Conference:

4.4.1.1 That all countries be encouraged to make full use of FAO regional facilities and those of other international agencies to develop sound statistical programs related to Crustacea; and that the free exchange of information between countries concerning methods and results obtained in statistical programs related to Crustacea be encouraged

4.4.1.2 That greater accuracy in landing data be achieved through the use of standardized conversion factors for the calculation of live-weight poundage, and that FAO be requested to compile and publish a list of such factors for use by all countries, and to develop a set of conversion factors for processed products in foreign trade

4.4.1.3 That biologists be included in all standing committees and working parties concerning fishery statistics, thus ensuring that programs are designed to furnish data for multi-purpose needs

4.4.1.4 That FAO establish guidelines for eliminating duplication in the reporting of landing data

4.4.1.5 That the "List of species of shrimps and prawns of economic value" be used for establishing standardized species nomenclatures for FAO statistical publications

4.4.1.6 That FAO publish in regional bulletins landings by major gear types, and include catch per unit of effort when it can be established

4.4.1.7 That FAO encourage each country to issue statistics on the amounts of shrimp and prawns produced by culture, and that these data be reported separately in the FAO Yearbook of Fishery Statistics

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4/ See Appendix 1 for members of the Working Party

4.5 Stock assessment

Convenor:	R. G. Chittleborough
Rapporteur:	E. S. Iversen
Documentation:	E/7, 34, 35, 42, 43, 45, 47, 51, 60
	SS/1 to 11

The documents presented, having as their principal objective the assessment of stocks rather than a descriptive biology of species, permitted a review of the knowledge of stock assessment of shrimps and prawns, progress made to date, and existing gaps. Papers were also included when they attempted to determine growth or natural mortality parameters, since these are employed for stock assessment.

The assessment of stocks may be used to compare the present level of exploitation with the maximum sustainable yield. Alternately, assessment may be attempted with a view to predict production from fishable stocks.

Some of the general characteristics of shrimp and prawn populations pertinent to the studies of their population dynamics include a short life span, very high fecundity and high larval and juvenile mortality. Recruitment is high, the newly recruited group forming a large proportion (in some species the total) of annual fishable stock. But what may be the most important difference between the dynamics of most teleost fish populations is that in shrimp and prawn populations recruitment is more variable, apparently owing to variations in components of fecundity, growth and especially natural mortality.

Ecological aspects can be important in stock assessment, and the suggestion that the Conference should stress the need for more studies in this field was strongly supported.

Progress indicated

(a) Species Synopses The 11 papers available constitute only a small fraction of the total number of species referred to, but they indicate progress towards assessment of shrimp and prawn stocks.

Under population structure, they indicate that a good deal is known of sex ratio and size composition but rather less about age. In the longer living species, such as pandalids and Crangon crangon, age structure has been recorded for some populations.

Growth rates have been recorded with considerable precision for some of these longer living species. Growth data recorded for penaeids under cultivation are very necessary, but it was agreed in other sessions that, when studying the dynamics of wild populations, such data may not be applicable or should be used with caution. Growth rates derived from the shift in modal size groups, using samples from wild populations, require a clear understanding of migration and dispersal to ensure that the same group is being followed.

Measurements of fecundity have been made on some species, but there is little indication of the influence of environment upon fecundity.

The only information on recruitment which has been noted in the Species Synopses papers was for Pandalus jordani and C. crangon.

Data on mortality rates are very sparse. There are some estimates for P. jordani showing variations between year classes as well as annual variations. Estimates of total mortality coefficient have been recorded only for Metapenaeus dobsoni and Penaeus setiferus.

There are a few records of relative abundance in terms of catch per unit effort, but only in the case of P. jordani have estimates of absolute density been attempted on the basis of catches and area swept by trawling gear.

No information whatsoever on population dynamics is provided by these 11 papers, suggesting that although a certain amount of descriptive data has been gathered, it is still not possible to understand for any shrimp and prawn population how these variables interact under the various environmental and fishing conditions. It is recognized that stock assessment may be achieved without conclusive results on every variable discussed above.

Although these Species Synopses do not cover the state of our knowledge on stock assessment of shrimps and prawns very effectively, approaches have been made in previous publications towards estimating population size, fishing mortality, immigration, and a combined figure for emigration and natural mortality for Penaeus duorarum in south Florida.

Recruitment appears to be the key to shrimp and prawn stock assessments, since recruits form a large proportion, if not the whole, of stock present at the beginning of a fishing season, so that the success of fishing varies as recruitment fluctuates. Three approaches towards estimating recruitment have been applied in shrimp and prawn research. The first employs quantitative or semiquantitative sampling of postlarvae or juveniles to predict level of recruitment. The second uses the marking and recapture technique, and the third is based on commercial catch and effort statistics. Each requires some knowledge of ecological aspects such as natural mortality, growth, and migration, in order to be applied effectively. Occasionally methods have been combined, as for example marking and catch per unit effort in a population of P. duorarum.

(b) Experience Papers' Since Pandalus borealis is one of the longer lived species, peaks in size composition within samples of the population, together with a knowledge of growth rate, enable relative strengths of year classes to be compared for several year classes. These fluctuations in abundance of year classes have been linked with the severity of the first winter immediately following hatching. Although these are relative rather than absolute values, they are interesting because annual fluctuations in recruitment are being linked with fluctuations in environmental conditions during the critical early phase. This is a useful step towards the understanding of dynamics of the Pribilof population of P. borealis.

Since P. jordani are not vulnerable to nets until their second year of life, a predator, the Pacific hake, is regarded as a better sampler than fishing nets. From length frequencies of shrimp samples taken by hake, and information on growth rates and age of sex transition, age composition was determined. The relative abundance of each year class was then expressed in terms of catch per unit effort by a fishing net. However, the drawback in this method is that it must be assumed the predator-prey relationship remains the same from one year to the other. Mortality rates were calculated from successive estimates of catch of each year class per predator-effort. Carefully planned sea surveys carried out while the independent samples were being collected from fish stomachs enabled some of the results to be cross-checked. Population estimates from the sea surveys were obtained by scaling up the mean catch per trawl by the ratio of survey area to area swept by one unit of effort.

By sampling the population of Artemesia longinaris in Argentina at frequent intervals and from the shift in modal sizes (aided by moulting studies in aquaria), it was possible to obtain von Bertalanffy growth curves for the population present during one

year. If these studies could be continued some measure could be made of the variability in growth rate from year to year, and correlations sought with environment factors.

One paper dealt with size at maturity, spawning frequency, and fecundity of several penaeid species of southwest India. If this work is to be taken as the first step towards assessments of stocks, two lines might be followed. If first-stage larvae of a species were readily accessible, a census of these might be applied to the fecundity which has just been measured, to obtain an estimate of the size of breeding stock. Alternatively, quantitative surveys of larvae or postlarvae might be implemented in order to measure pre-recruit survival.

The latter approach, quantitative sampling of larvae and postlarvae to determine density, and hence total crop passing through various stages of development, was demonstrated in another paper. By this method estimates of P. duorarum through to the Everglades nursery area were obtained. This approach represents an important step forward in understanding the dynamics of shrimp populations.

A good positive correlation between relative abundance of juvenile P. duorarum leaving the nursery areas and the landings of the smallest size groups of the commercial catch a short time later was demonstrated in another contribution. This approach, applying quantitative methods, has already reached the stage where a system can be formulated for forecasting relative abundance of pink shrimp on the fishing grounds. Perhaps in the future it will be possible to measure survival rates and thus predict actual yields for each crop of juveniles.

An attempt was made to link the relative abundance of postlarvae entering a nursery area with the juveniles departing from the area, and linking both peaks in abundance with the commercial catch off shore. The results obtained give a fair understanding of the annual fluctuations in adult stock over the past seven years.

Models for stock assessment of shrimp and prawns are very limited. However, an impressive model for the Shark Bay prawn fishery, designed to obtain specific information on the dynamics of the two populations involved, was presented. The pre-requisite of precise and complete data on catch, effort, and catch composition is underlined by this model.

Discussions in this session made it evident that for many of the measurements required in the dynamic equation some limited information is available for most of the shrimp and prawn species referred to. Relatively complete data on the subject of population dynamics are available only for a few species.

4.5.1 Recommendations

The Conference recommended that:

4.5.1.1 For effective stock assessment of shrimps and prawns, considerable descriptive work on their biology is required. It is urged that these studies be designed with the specific objective of assessing stock size and its variability

4.5.1.2 Rather than make standing crop estimates, stock assessment should cover several years so that:

(i) variations in recruitment into the fishable stock can be related to fluctuations in environmental conditions

(ii) The level of fishing can be related to the maximum sustainable yield from the fishery

4:5:1:3 Because of the many pitfalls involved in estimating population dynamics in this group, including the wide variability, investigations should employ more than a single approach so that results may be cross-checked.

4:5:1:4 Investigators should continue to develop new methods and techniques to estimate stock density and size. Possible lines include the use of sonar and visual scanning aids.

4:5:1:5 Estimates of stock size should be translated into terminology which is directly understandable by and applicable to the fishing industry. Frequently stock size alone is insufficient to help the fishing industry and the economics of the fishery must be considered. In the final event, the biologist, economist and industrialist must work together to capitalize the results from the biological data which has been obtained

4.6 Culture of shrimps and prawns

Convenor: A. C. Simpson

Rapporteur: D. A. Hancock

Since the papers submitted covered two kinds of culture techniques, it was considered appropriate that this topic be dealt with in two separate sessions: pond culture and artificial culture.

4.6.1 Pond culture

Documentation: E/18, 25

R/2, 4

RS/1

Pond culture has been practised for a long period in the Indo-Pacific area, and the papers presented reviewed methods in India, Malaysia and the Philippines. Basically, pond culture in this region depends on the habit of penaeid shrimps to arrive in shallow coastal areas at postlarval and juvenile stages, when they enter artificial ponds through open sluices during flood tide. During their stay in these ponds they grow by feeding on natural food found there as well as that carried in by the tide. Subsequently these shrimps are harvested by means of filter nets placed on the sluices during the receding tide, or when the ponds are completely drained.

In India rice fields of 1 to 10 ha are used during the six-month period when rice cultivation is not pursued, while in Malaysia the carefully chosen ponds in the mangrove swamp areas are of 12 to 16 ha. Culture methods in the latter are similar to those employed in India.

One paper reported results from experiments designed to study the effects of rearing shrimps in the Indian paddy fields for different periods. It was concluded that harvesting at monthly intervals gave greater yield than harvesting at the end of a long culture period. Experiments on size composition of shrimps entering and leaving the ponds showed that these remained for approximately 5 to 6 weeks before being caught in the outgoing water.

Discussions revealed that three major kinds of pond culture are pursued in India: (a) rotation with rice, (b) together with rice, and (c) in compartments along the river banks on low areas of poor agricultural value. Pond culture in Pakistan, Singapore, Viet-Nam and Cambodia is basically similar to India but none exists in Burma and Hong Kong. In Thailand, both converted rice fields and converted salt fields are utilized, while in Indonesia shrimp harvesting is incidental to the farming of brackish-water fish. In Taiwan, culture by both methods, as practised in India and the Philippines, yields a harvest approximately three times that in the Philippines. It is not clear whether generally it is more economic to culture shrimps alone or with fish, but in Taiwan the latter method is very successful.

In the Philippines methods are more advanced and culture is based on a single species, Penaeus monodon, known as sugpo. In the past, sugpo culture was carried out in association with the fish Chanos chanos, but as a result of higher prices paid for sugpo it is being replaced by pure sugpo culture. Selected areas, portioned into nursery and rearing ponds, are carefully prepared to induce growth of bottom flora and fauna (lab-lab), serving as food for the young fry. Sugpo fry, caught by various means in the shallow areas, are placed in nursery ponds and transferred after a period of 1 to 1½ months to the rearing ponds at about 20,000/ha, where supplementary food is given.

Harvesting is carried out by nets and traps. It was mentioned that the pond area of 130,000 to 150,000 ha is expected to increase.

Discussions on comparative economics showed that pond culture is expensive but returns can be high, especially where live shrimps are in demand. On the other hand, harvesting by fishing vessels can also be expensive and the economics of the two systems should be examined. If the causes of mortality in pond culture could be overcome, the running costs would be reduced. Great interest is shown in investment in this field; however, the opinion was expressed that the risk of destruction by typhoons discourages extensive investment.

Production figures given for the Philippines appeared to be too low. It was mentioned that females are known to grow faster than males and those harvested from ponds are 2 to 3 times as large as males. Food conversion by female C. crangon is also more efficient than male and it was suggested that, on the basis of work on Crangon done in the Federal Republic of Germany, similar research be undertaken on penaeids with the possibility of (a) early separation and rejection of males from culture, and (b) influencing sex by producing ecological conditions favourable to females.

Comments made on the paper related to pond culture in Singapore indicated that the industry is dying due to shortage of land and for political reasons. Although the pond culture comprises a balanced ecosystem including 13 penaeids and 7 carideans, only 6 penaeids are commercially important; the remaining trash prawns, although edible, are disliked locally. Year-round availability is based on one breeding season of Penaeus, alternating between two of Metapenaeus per year. Fertilization has been found of doubtful value and is said to increase silting.

Reference was made to the extensive occurrence and future developments of shrimp culture along the Pacific coast of Mexico, in ponds distant from the sea but connected by long channels, and where yields are still low. It was suggested that suitable areas for pond shrimp culture exist in Nicaragua. In Peru efforts are being made to restock coastal rivers and ponds with fry of the freshwater shrimp, Cryphiops caementarius. In 1965 one breeder was supplied with 10 million fry. Fry up to 60,000 per 15 minutes can be harvested from the lower parts of rivers.

The conclusion that adequate additional food is necessary to reduce cannibalism was supported, with emphasis on the right kind of food. Suggestions were made that overdensity of population aggravates cannibalism. The provision of hiding places for molting shrimps may, however, reduce it.

It was considered that more research is required on (a) diseases of shrimps in ponds, (b) chemical and physical conditions and trophic levels in ponds, and (c) yields and economics of pond culture compared with normal harvesting. Closer liaison is needed between scientists and industrialists, with greater conference participation and more experimental work undertaken by the industry.

Pollution problems require urgent attention. In the United States, legislation to reduce pollution and control physical alterations to estuaries has already been discussed by Congress during 1966 and 1967.

4.6.2 Artificial culture

Documentation: E/2, 30, 31, 37, 44, 53, 63

R/1

The subject matter of this session was divided into (a) procedures of rearing and (b) the choice of suitable species for rearing.

4.6.2.1 Procedures for rearing The successful rearing of shrimps and prawns on a commercial scale has as yet been achieved only with Penaeus japonicus in Japan and Macrobrachium rosenbergii in Malaysia, though considerable progress is reported for Palaemon serratus in the United Kingdom.

Comparison of the features of spawning and larval stages

	P. japonicus	M. rosenbergii	P. serratus
Eggs	Planktonic	Carried by female	Carried by female
Fecundity	300,000 - 500,000	60,000 - 100,000	500 - 3,000
Duration of egg stage	Few hours at 26°C and 27‰	3 weeks at 26°-28°C and 12-16‰	4 weeks at 20°C and 25-35‰
Duration of larval stage	21 - 25 days at 26°C	4 - 5 weeks at 26-28°C	3 weeks at 20-25°C
Food of larvae	Diatoms followed by Artemia	Artemia, plankton, artificial foods	Artemia
No. larval stages	13 (reaching 12 mm)	8 (reaching 6 mm)	7 (reaching 7.5 mm)

The culture of M. rosenbergii has now reached a stage where it permits juveniles to be grown by private producers on a large scale, all the major problems having been overcome. Rearing of P. serratus is still on a laboratory scale but substantial numbers have been reared through all stages, and knowledge of optimum conditions of temperature, salinity, light, food and density have been established for the larvae. However, more studies are required on diseases and an alternative food to Artemia and the selection of fast-growing and disease-resistant strains should be investigated.

4.6.2.2 Choice of suitable species for culture The consideration of appropriate species for rearing has led to the view that rearing would be simplified if caridean prawns with abbreviated or no larval stage were used, such species being found particularly among fresh and brackish waters or in cold or deep seas. Experiments using related species with long or short larval stages supported this perspective. During discussion it became clear that larvae can live for long periods undergoing numerous moults but without growth or metamorphosis, and that incorrect feeding is likely to be the cause.

Attempts to assess the potential value of freshwater prawns in Malaysia as food organisms led to research on suitable species for culture. The freshwater species Cryphiops lanchesteri has been recommended for culture in view of its being able to proliferate in stagnant water of low mineral content, to tolerate reduced oxygen and temperature up to 35°C, and because it is believed to be herbivorous and therefore less likely to exhibit cannibalism.

Other desirable characteristics required from shrimps and prawns for culture are:

(i) High-protein conversion factor and fast growth

(ii) Herbivorous habits so food cost can be reduced

(iii) Tolerance to change in environmental conditions

(iv) Non-aggressive habits, thus reducing cannibalism

In searching for suitable species, it was suggested that:

(i) The less common species be studied

(ii) Several favourable species are needed to meet the required conditions in different parts of the world

(iii) Coastal and freshwater species are most likely to be more tolerant to artificial conditions

The highlight of this session was the presentation of papers related to advances made in Japan and Malaysia on artificial culture techniques and the evoked discussion. In view of the importance and commanding interest of this subject, the important points disclosed by the author on methods practised in Japan are given below:

The system whereby Penaeus japonicus are reared artificially to juvenile stage has been adopted also for P. semisulcatus and Metapenaeus monoceros. Since 1964 the system has changed from indoor to outdoor concrete tanks of a capacity 100 times greater. Instead of rearing pure cultures of plant food separately, diatoms are retained by filtering coastal water through vinylon cloth and intense proliferation encouraged by full sunlight, strong aeration, and the addition of nutrient salts. The culture obtained affords protection to larvae from the sun and provides abundant healthful food. Eggs are obtained from a batch of female shrimps ready to spawn. Twenty females are placed in small tanks; about half of them spawn overnight and the eggs hatch in a few hours but hatching is not total. Development to juveniles weighing 0.02 g takes 25 days. Once this stage is reached, they are placed in polythene bags containing water and sufficient air for 20 hours and distributed to commercial shrimp culturists.

Survival from nauplii to zoea is 90 percent, from zoea to mysis 70 percent and from mysis to postlarval 90 percent, the zoeal stage requiring 4 to 5 days and mysis 3 to 4 days. Artemia nauplii are added to the mysis stage and need to be abundant to reduce cannibalism among postlarvae. Four days after the postlarval stage has been reached, feeding with clams and partial changing of the water commences and postlarvae settle to the bottom. At the zoeal stage the water is fertilized every 24 hours with 50 kg of potassium nitrate and 5 kg of potassium phosphate per 100 t of water.

No attempt is being made to control temperature or salinity, and survival is not affected up to 30°C and down to 20 °/oo. Production has increased from 1 million juveniles per tank in 1964 to 1.6 million in 1966, and at present exceeds the requirements of culturists. The surplus has been utilized to improve shrimp stocks in selected bays and some improvement to yields has been observed. During 1966, 13 million juveniles were liberated between Hokkaido and south Japan. Although no survival rates

are available, it appears these are higher in shallow waters with gentle slopes and algal abundance than in deep bays. Production costs have decreased considerably. Since 1965 the cost of 20 to 30 juveniles is 1 U.S. cent, all costs included, and production of 50 million can be achieved by 5 men. Tanks can be utilized throughout the 6 summer months by collecting breeding females from different parts of Japan. Production is not practicable during the cold winter months. Growth to the desired market sizes of 20 g takes about 5 months, and two culturists with 11 stations supplied 200 tons to restaurants.

During the ensuing discussion it emerged that Mytilus is also used to feed juveniles and that spawning can be activated by increasing pH. Females grow faster than males, but the difference is not apparent until the animals weigh 15 to 20 g, shortly before market size. There is no reported flavour change related to different food, although one author found the flavour of C. crangon fed on crustacea to be superior to those fed on worms. There were no disease problems, except for a darkening of gills. Some experiments suggest that shrimps prefer animal food free from haemoglobin.

Artificial culture of Penaeus orientalis on a commercial scale, based on Japanese methods, has been achieved also in Korea.

One paper dealt with the culture of M. rosenbergii in Malaysia. The most important remaining problems are of food and feeding and controlling mortality due to diseases and cannibalism. Governmental hatcheries supply juveniles free of charge to encourage industrial developments, and at present costs are not available. When juvenile prawns are reared in ponds, usually with non-carnivorous fish, natural food is supplemented by trash fish. Prawn production of 100 to 200 kg/ha per annum by culturists is in addition to the primary product of fish.

During the general discussion it was suggested that in addition to attempting to initiate natural conditions and natural food, more efforts should be concentrated on methodology and novel practices and less on economics at this stage. Investigations should be oriented towards foods more readily banked, like synthetic, freeze-dried, and even encapsulated foods of chemically defined character, in which might be incorporated flavours to reduce cannibalism, chemicals to produce sex change, etc. It was pointed out that micro-encapsulation has already been used for feeding molluscs, and perhaps dried and solubilized waste animal protein may have a role. Food like Artemia has the advantage of calibrating feeding rates and efficiency, though Artemia has not always been found to be of high food value.

4.6.3 Recommendations

The Conference recommended that:

4.6.3.1 Statistics of yield from pond and artificial culture be recorded separately from those of normal harvesting

4.6.3.2 A survey be undertaken of the economics and yields of pond culture as compared with normal harvesting

4.6.3.3 Closer liaison be established between scientists and industry in the planning and application of research on pond and artificial culture

4.6.3.4 At the FAO Conference on Marine Pollution and its Effects on Fishery Resources and Fishing, to be held in 1969, special attention be given to:

(i) Pollution in shallow waters and its effects on crustacean and molluscan resources

(ii) The future development of artificial cultures

4:6:3:5 A FAO World Conference be organized on the subjects of artificial rearing of marine organisms of commercial importance and habitat improvement

4:6:3:6 More research be undertaken on:

(i) Preferences between different shrimp and prawn species for different types of food and their relationship to survival and growth

(ii) The role of synthetic and other food materials in artificial culture

(iii) The possible use of hormones and other chemical regulatory substance and their effects on behaviour and growth

4.7 Standardization of research methods

Convenor:	T. H. Butler
Rapporteur:	J. Carranza
Documentation:	E/1, 7, 11, 14, 16, 17, 20, 21, 26, 28, 29, 30, 37, 47, 58, 59, 61
	R/4
	SS/1 to 11

Although descriptions of methods employed have been referred to in various documents, only eight were directed to methodology. Methods pertaining to shrimp and prawn culture and to statistics have not been considered here.

In view of the variety of methods employed and the usefulness of comparing and evaluating results, the objectives of this session were to explore problems related to shrimp and prawn research methods, and to consider possibilities of their standardization. The various methods applied by authors on a particular research subject, and comments made during discussion on their improvement, are summarized below. The necessity of preparing a manual on methodological procedure was recognized.

Exploratory fishing: One paper described methods of collecting biological data during operations off north-northeast Brazil, and another around Cuba, the latter referring in addition to meteorological and oceanographical observations made. Sampling of catches to determine species, sex ratio, size composition of shrimps and prawns, and species composition of associated fauna was considered essential. Sample size could be determined statistically prior to surveying. Exploratory fishing can be assisted by the application of life history and ecological knowledge of shrimp and prawn species occurring in the region. Although location of fishing grounds and fishing methods had not been considered, it was suggested that sonic methods and echogram interpretation be included in a manual.

Measurements: In measuring size, most commonly expressed as length, three dimensions are used: total, carapace, and body or tail length. As a matter of interest, in the papers reviewed, 23 refer to total length, 7 to carapace, and 16 to both dimensions; in addition, one refers to body length and one to body.depth. If carapace length is applied, the relationship of this measurement to total length should be expressed as a conversion factor. A single factor may be inadequate for some species. It was agreed that standardization of length dimensions is not practical among species, but is within a species. Whatever dimensions are applied, they should be well defined.

Only one paper described a method of weighing. In view of the importance of length-weight relationships some standardization on weighing was considered desirable.

Marking: Although marking methods have been referred to in the species synopses on Crangon crangon and Penaeus setiferus, no review paper on this topic had been presented. A summary of marking techniques with biological stains was provided by a participant in the Conference. Shrimps as small as 40 mm in total length may be marked, with the stain being visible up to 11 months. Between 300 and 400 may be marked per hour, and cooking does not reduce color intensity substantially.

Larval and postlarval sampling: Two papers dealt directly with this subject. For larval stages, high-speed plankton nets appear to be adequate, except for shallow waters, where a standard 1 m net is more successful. For postlarvae sampling, the latter also appears to be preferable. Errors in depth and flow determinations may be avoided by employing accurate indicators which have recently become available.

Maturity and fecundity Methods to determine maturity in Penaeus californiensis, Solenocera indica and five other penaeid species of the southwest coast of India are dealt with in three papers. In two, the definition of five maturity stages appear to be acceptable to research workers on penaeid shrimps. Fecundity has been determined either by subsampling the mature ovary, or by direct count.

Other methods Description of methods related to examination of penaeid stomachs, determination of stages of the moulting cycle in Penaeus duorarum, determination of P. vannamei postlarval entry into estuarine waters, rearing of penaeid larvae, and of a computer program, were dealt with in five experience papers. A description of a method for clearing appendices of postlarval shrimp was also handed to the Convenor at this session.

4.7.1 Recommendations

The Conference recommended that:

4.7.1.1 FAO should undertake the preparation of a manual of accepted methods on shrimp and prawn research. Before the manual is drafted, preliminary circulars should be issued to specialists according to the following priorities:

(i) Measurements

(ii) Sampling during exploratory fishing

(iii) Sampling of larval and postlarval shrimps and prawns

(iv) Determination of maturity and fecundity

so their comments and suggestions can be sought

4.7.1.2 A training centre on research methods be organized by FAO, bearing in mind regional needs

4.7.1.3 The use of circulars by national and international agencies be promoted and the texts revised continually in the light of experience gained by their use

4.7.1.4 The FAO series of manuals on fishery methods be brought up to date and given wide distribution

4.8 Ad Hoc Working Party on FAO Indicative World Plan (IWP) Survey of Crustacean Resources

Convenor: A. R. Longhurst 5/

The origin and scope of FAO's Indicative World Plan for Agricultural Development, (a section of which implied a world-wide survey of crustacean resources) was outlined on the basis of a draft document. Discussions followed on the actual form of the document as distinct from its contents. It was generally agreed that the final document would be improved if it contained (a) an introduction to the ecological nature of crustacean resources, (b) an agreed taxonomic list of economically important species such as is being studied (see 4.2.3), and (c) a bibliography considerably more extensive than that provided in the draft, which might best be subdivided by geographical regions and which should treat well-explored and little-explored regions of the world differently, ensuring that coverage of the latter included more basic references than recent reviews.

Views were expressed that distinctions must be made in the included data between economic and biological potential and it was emphasized that the data are required on three levels: (a) present knowledge of exploited stocks, (b) predictions of potential resources based on actual surveys and (c) hypotheses concerning probable resources, based on educated guesses rather than actual exploration.

It was suggested that a coding for species stocks, areas and the state of the stocks would be useful, and it was pointed out that this would be covered by tabulation of data from the text of the final document.

The Convenor led a discussion of the draft document, region by region, and specialists from each region were appointed to report on resources from their areas according to the requirements of the original request for information. These people agreed to contact other sources of information in their regions to obtain the data required to amend the draft document, and to send such information to the Convenor, who agreed to collate it and submit it to FAO, who will produce the amended draft. It was hoped that FAO would be able to feed back to regional rapporteurs the original data on which the document was based.

The regional rapporteurs were:

1.	Atlantic Ocean,	east-central	A. R. Longhurst (U. S. A.)
2.		northeast	A. C. Simpson (United Kingdom)
3.		northwest (ICNAF)	S. Apollonio (U. S. A.) B. Rasmussen (Norway) H. J. Squires (Canada)
4.		southeast	(not nominated)
5.		southwest	E. E. Boschi (Argentina)
6.		west-central	M. J. Lindner (U. S. A.)
7.	Indian Ocean,	east	D. N. F. Hall (United Kingdom)
8.		west	
9.	Mediterranean Sea		M. Massuti (Spain)
10.	Pacific Ocean,	east-central	R. W. Ellis (Costa Rica)
11.		northeast	T. H. Butler (Canada)
12.		northwest	B. Ivanov (U. S. S. R.)
13.		southeast	D. A. Hancock (Chile)
14.		southwest	W. B. Malcolm (Australia)
15.		west-central	A. Sribhibhadh (Thailand)

5/ See Appendix 1 for members of the Working Party

5. CLOSING SESSION

At the final plenary session an address was given by the Chairman, Dr. C.P. Idyll, (Appendix 5) and the following resolution expressing the participants' appreciation to the Government of Mexico was unanimously adopted:

> "That this World Scientific Conference on the Biology and Culture of Shrimps and Prawns during its terminal session this day, 21 June 1967, wishes to record its deep appreciation of the extensive time and effort given by the Government of Mexico and our many Mexican friends to making this Conference so highly successful, and in addition wishes to express its sincere thanks to all for their bountiful hospitality."

The closing ceremony took place on Tuesday morning, 21 June 1967. Dr. M. Ruivo, speaking on behalf of FAO, emphasized the importance of the Conference in which more than 200 scientists and representatives from 36 countries and international organizations had participated.

Dr. D. N. F. Hall (United Kingdom) then proposed a vote of thanks to the Secretariat staff provided by the Host Government.

Lic. A. Cervantes Delgado, representing Lic. O. Campos Salas, Honorary President of the Conference, after expressing the appreciation of the Government of Mexico to all the participants who had contributed to the success of the Conference, declared the Conference officially closed:

> "At 12:35 today, 21 June 1967, on behalf of my Government it gives me great pleasure to declare closed the FAO World Scientific Conference on the Biology of Shrimps and Prawns."

6. ACKNOWLEDGMENTS

The FAO Department of Fisheries, recognizing that the undoubted success of the Conference was in large measure due to the outstanding cooperation and support given by the Government of Mexico, wishes to thank the following officials of the Secretaría de Industria y Comercio whose support made the Conference possible:

Lic. Octaviano Campos Salas
Secretario de Industria y Comercio

Lic. Plácido García Reynoso
Subsecretario de Industria y Comercio

Lic. Sergio Luis Cano
Subsecretario de Industria y Comercio

Lic. Francisco Rodríguez Gómez
Oficial Mayor

Lic. Jorge Echániz R.
Director de Pesca

Biól. Juan Luis Cifuentes Lemus
Subdirector de Pesca

Lic. Alejandro Cervantes Delgado
Subdirector de Pesca

In addition, mention should be made of the numerous and enjoyable social events organized in honour of the participants (Appendix 6) which were greatly appreciated.

Special thanks are also due to Prof. Octavio Trías Aduna of the National Tourist Council who presented the participants with many publications on Mexico.

Appendix 1

OFFICERS OF THE CONFERENCE

Honorary President	Lic. Octaviano Campos Salas	
Chairman	Dr. C. P. Idyll*	
Vice-Chairmen	Prof. J. L. Cifuentes Lemus Dr. M. Fujinaga* Dr. M. Massuti*	
Convenors and Rapporteurs		
Resource appraisal	Mr. M. J. Lindner	Dr. J. H. Kutkuhn*
Life history	Dr. K. F. W. Tiews*	Mr. J. J. Ewald
Physiology and behaviour	Dr. H. Schafer	Prof. A. B. Williams
Statistics of catch and effort	Mr. J. L. Obarrio	Mr. R. W. Ellis*
Stock assessment	Dr. R. G. Chittleborough	Mr. E. S. Iversen
Culture of shrimps and prawns	Mr. A. C. Simpson*	Dr. D. A. Hancock
Standardization of research methods	Dr. T. H. Butler	Dr. J. Carranza
FAO Indicative World Plan (IWP) survey of crustacean resources	Dr. A. R. Longhurst*	
Other members of the Consultative Group	Dr. E. E. Boschi Dr. D. J. Crisp Dr. D. N. F. Hall Dr. L. B. Holthuis Mr. G. de S. Neiva Dr. M. Nikolić	
Secretariat		
Mexican Government		
Chief Coordinator	Prof. J. L. Cifuentes Lemus	
Coordinator	Lic. T. Gutiérrez Olguín	
FAO		
Representative of the Director-General	Dr. S. J. Holt	
Representative of the Department of Fisheries	Dr. M. Ruivo	
Scientific Secretary	Mr. M. N. Mistakidis	
Liaison Officer	Dr. C. Miles	
Administrative Secretary	Miss M. C. de Freitas	

*also members of the Consultative Group

MEMBERS OF AD HOC WORKING PARTIES

Ad hoc Working Party on the FAO Indicative World Plan (IWP) Survey of Crustacean Resources

Convenor: Dr. A. R. Longhurst

Dr. E. E. Boschi
Mr. G. C. Broadhead
Dr. T. H. Butler
Mr. E. L. Cadima
Mr. H. Chapa Saldaña
Dr. R. G. Chittleborough
Mr. R. W. Ellis
Prof. F. S. Gneri
Dr. D. N. F. Hall
Dr. D. A. Hancock
Dr. L. B. Holthuis
Mr. B. Ivanov
Dr. J. H. Kutkuhn
Mr. M. J. Lindner
Profa. María Teresa López
Dr. M. Massuti
Mr. J. L. Obarrio
Dr. B. Rasmussen
Mr. A. C. Simpson
Mr. J. G. Simpson
Mr. R. J. Slack-Smith
Dr. H. J. Squires
Dr. K. F. W. Tiews
Mr. D. Weber
Prof. A. B. Williams

Ad hoc Working Party on Fishery Statistics (Crustacea)

Convenor: Mr. G. W. Snow

Mr. G. C. Broadhead
Mr. M. Cardenas Figueroa
Mr. H. Chapa Saldaña
Mr. R. W. Ellis
Prof. F. S. Gneri
Dr. J. H. Kutkuhn
Dr. M. Massuti
Mr. J. L. Obarrio
Dr. B. Rasmussen
Mr. A. C. Simpson
Mr. R. J. Slack-Smith
Dr. A. Sribhibhadh

Ad hoc Working Party on the List of Species of Shrimps and Prawns of Economic Value

Convenor: Dr. L. B. Holthuis

Dr. E. E. Boschi
Dr. Isabel Perez Farfante Canet
Dr. S. Dobkin
Dr. Isabella Gordon
Dr. D. N. F. Hall
Dr. K. F. W. Tiews

Ad hoc Working Party on the Taxonomy and Identification of Larvae and Early Post-larvae of Shrimps and Prawns

Convenor: Dr. S. Dobkin

Dr. E. E. Boschi
Mr. H. L. Cook
Dr. S. W. Ling
Mr. A. J. Provenzano, Jr.

Appendix 2

A G E N D A

1 Resource appraisal

2 Life history

3 Physiology and behaviour

4 Statistics of catch and effort

5 Stock assessment

6 Culture of shrimps and prawns

7 Standardization of research methods

8 FAO Indicative World Plan (IWP) survey of crustacean resources

Appendix 3

ADDRESS AT THE INAUGURAL SESSION

by

LIC. ALEJANDRO CERVANTES DELGADO
Assistant Director for Economic and Fisheries Affairs

Mr. Plácido García Reynoso, Under-Secretary of Industry and Commerce; Dr. Sidney Holt, representing the Director-General of FAO; Dr. Miguel de Albornoz, Mexican Representative to the United Nations Development Programme; Mr. Adolfo Alarcón, Assistant Regional Representative of FAO for Latin America; Guests of Honor; Participants in this Conference; Ladies and Gentlemen:

It is a great honor and a matter of great satisfaction for me to welcome on behalf of my Government such a select group of scientists and technicians from all corners of the globe gathered here to consult each other and exchange experiences in one of the many fields of scientific research: shrimp and prawn biology.

This is neither the correct time nor place even to outline the long and impressive history of science dealing with the exploitation of marine resources. Yet I do consider it vital to mention one fact that is pertinent not only to such study but to the whole enormous task of achieving scientific and technological progress upon which mankind is embarked considering the aims, variety of methods and broad scope of this work. This unending, multifaceted task involving citizens of many nationalities, creeds and backgrounds, opens new avenues to international co-operation and the conquest of nature; above all, however, it opens the road to peace and harmony among nations, built not on fear but on understanding; may this peace and harmony be lasting!

Science - objective and selfless - seems to be the hope and guide of our times; it furnishes the great lesson of generosity, promoting justice and social balance.

Our growing interest in encouragement of scientific research and technology is neither accidental nor fortuitious. The United Nations and each of its Specialized Agencies, the governments of both the more developed and the emerging countries, and private enterprise are all contributing ever larger funds for the attainment of these noble ideals.

Man's demand for a better life, free of want, is being more and more strongly and insistently voiced throughout the world.

This, as I see it, is the reason the United Nations, and especially FAO, are anxious to have men pool their experience, exchange ideas and hold conferences in which those who subscribe to scientific humanism participate, men and women like yourselves who are striving to restore to scientific creativeness its essential role as the harbinger of welfare and happiness.

It is universally recognized that, for science to make progress, theory and practice must go hand in hand. This can readily be accomplished in the rich and more advanced countries, but the vast "third" world, with less resources and where scientific work is only in its infancy, can contribute very little to universal scientific theory. Mexico is enthusiastically and unswervingly marching along the road to development, but unfortunately is still in the latter category.

Indeed we watch with great admiration the formidable progress being made in the application of science to the processes of primary production, especially in agriculture and fisheries, and the unceasing appearance of new scientific and technological

inventions strengthening the foundations of industry and the service trades. Frequently, however, our admiration is tinged with discouragement, for even when we learn of the scientific achievements of the more advanced countries we are not in the position to apply them, chiefly because of insufficient economic means.

Above all, when we think of the enormous volume of resources allocated to the production and perfection of instruments of war, of materials the only purpose of which is massive destruction, our discouragement turns into dismay. For - a sad fact to be reminded of just now - neither science nor technology have remained extraneous to negativistic tendencies although it is true - and this is encouraging - that there is a great legion of men working in science and technology for peaceful purposes. It is equally true that the arms race swallows up much of the labour force and economic resources of the great powers. This fact strengthens our conviction that we must struggle resolutely to take scientific research out of the service of war and discord. At best, science wasted thereon will be sterile. The efforts of all men and all nations should be bent in the opposite direction, toward productivity instead of belligerency; toward construction rather than destruction.

Until international disarmament becomes a reality, or at least until the arms race has been stopped, the co-operation of countries of goodwill with the dedicated support of world-wide organizations like FAO will continue to be essential for the development of scientific theory and practice in emerging countries.

The uneveness of development observable in many phases of economic life between a few major powers and the vast majority of member countries of the United Nations is evident in the field of fisheries as well. Therefore FAO's task of encouraging scientific investigation and sponsoring broad yet coherent international programs deserves our recognition.

Because the living conditions of a vast majority of the world's population are still deplorable, the emerging countries have the imperative obligation to make the utmost use of the advances achieved in the great centres of research for the best possible exploitation of their own resources.

Scientists setting out today to study the seas start out from advance bases of research, and with perseverance they will gradually establish new outposts of progress in scientific knowledge. The food deficiencies from which a great portion of humanity still suffers and the sombre predictions made by FAO as to the outlook for food production in the world, demand that oceanographic research be intensified. The investigation of aquatic resources must be systematic, comprehensive and thoroughgoing, not stopping at the upper surface of the oceans but penetrating into the mysteries of their currents and abysmal depths, so as to obtain the greatest benefit from the resources they offer us.

Unfalteringly moving ahead on the road to the material welfare of humanity, we must quicken our pace in scientific reserach for peaceful purposes. We must multiply our exchanges of experience, affording, as at this conference, opportunities for obtaining a panoramic view of present scientific achievements in all their up-to-date, wonderful complexity.

The occasion that brings us here today reveals FAO's deep concern to establish order and co-operation and improve conditions in the major sectors of fisheries. That is why it has convened this World Scientific Conference on the Biology of Shrimps and Prawns after the 1959 Meeting on Sardines and Related Species in Rome, and the 1962 World Scientific Conference on the Biology of Tuna and Related Species in La Jolla, California, the results of which have proven so beneficial to the countries participating.

The Government of Mexico, as your host, is confident that the Conference will be notably successful also in promoting the exchange of information on the classification and distribution of fish stocks, their spotting and assessment; on the life cycles, physiology, behaviour and breeding of certain species as well as on fisheries statistics-in short, all information regarding marine resources, fishing methods and the rational exploitation of the seas.

Allow me to describe in very general terms the beginnings of fisheries in this country.

In Mexico, fishing dates back to the very start of the Mayan and Totonaco civilizations and to that remote time when the tribes of our ancestors settled on the shores of the great Lake of Tenochtitlán. They caught not only fish but also great quantities of what they call "acocil" or freshwater shrimp and certain other species which have only recently begun to be eaten in other countries, frogs and turtles. Legend has it that from the coasts of what is now Veracruz, fleet and tireless relay runners, well organised, carried succulent fish fresh from the gulf to the table of the great Montezuma. Somewhat later in our history the Conquistadores directed the economy toward mining and the formation of large landed estates, the latifundia, rather than toward fisheries.

My country, torn by internal strife and foreign intervention during the first decades of its independence, could not undertake the exploitation of its own sea resources, so that ships from other latitudes pillaged our wealth. Even though our republican institutions had become consolidated by 1867, it was not until after the revolution of 1910 that we started to outline our political and social policies in which for the first time fisheries received some attention. Indeed it was not until our revolution had reached its constructive stage that effective improvements were made in this occupation. One particular improvement desrves mention: the concession to fishermen's co-operatives of exclusive rights to catch shrimp, lobster and five other leading species.

The most curious feature of fisheries in present-day Mexico is the narrow range of species landed; one species alone, shrimp, constitutes about one quarter of the total catch and nearly 60 percent of its commerical value. The preponderant emphasis on this crustacean is evident if we consider that over half of the fishing fleet is made up of shrimpers and over two-thirds of the net annual investment in fisheries also goes to this speciality. It is indeed the main source of foreign exchange, as in recent years shrimp exports occupy fourth and fifth place in our total sales to foreign countries.

Various fishing centres of this country owe their development to the exploitation of this crustacean. The vitality of ports such as Guaymas, Mazatlán, Salina Cruz and Ciudad del Carmen, is the result of the abundance of this one species, and the contribution of the co-operatives, both private and government sponsored, has been the determining factor.

Notwithstanding the preponderance of shrimping in Mexico's fisheries, neither the shrimping fleet nor its industrial processing plant are working at full capacity, a circumstance which forces us to intensify our biological and technological studies and to seek new markets. Considering Mexican fisheries as a whole, we must recognize that production levels and structures are not in keeping with our degree of economic development, nor do they cover the food requirements of our population. The contribution of fisheries to our gross national product is relatively low, representing only 0.3 percent of the national production of goods and services. The number of people directly deriving their livelihood from this occupation is also relatively low, and the per caput consumption of fishery products is scarcely 3 kg a year.

Considering this situation and with full awareness of the potential wealth represented by our marine resources and the greatly significant increased production and consumption of this sea food in the future economy and the diet of a constantly growing population, the Government of President Diaz Ordaz is unswerving in its purpose of promoting this economic activity.

In 1966, it became possible to shake fisheries out of the stagnation of the previous two years and obtain landings of 207,000 tons, worth 828 million pesos - an increase of 10 and 14 percent respectively over the 1965 figures. Indeed, although the catch of all species did not increase, it is gratifying to point out that the greatest expansion was achieved in landings of species of popular consumption and in products the supply of which still does not meet internal demand, for instance, fish meal.

Shrimp landings that year also showed a considerable increase, as nearly 40,000 tons were obtained, 12 percent more than in 1965 and, a very important point, this reported percentage increase in fish landings was greater than the rise in gross national product (7 percent) or in the rate of expansion in industry (8.6 percent). The 1966 upward trend noticed in aggregate fishery production has continued for the first months of 1967. During the first quarter an increase in the total catch 23 percent higher than for the same period in 1966 was recorded.

Even though it is encouraging to note this degree of recovery of Mexican fisheries one must realize that the rate of development can, and must, be further improved, due to the relatively low levels of production under present conditions and especially remembering that the development of this industry, besides requiring firm foundations, needs to be balanced as much from the regional as from the structural or sectorial standpoint. For this reason the fishery development program of the present Administration, while basically aiming at increasing the shrimp catch also calls for diversification and overcoming of the handicaps of present structures - all with a social purpose, that is: more fish consumption by the people, greater industrial exploitation of aquatic resources and improvement in the living conditions of fishermen.

Along this same line of thought it is well to repeat that before availing ourselves of offers of foreign financing, we should undertake detailed technical studies so as to avoid over-investment in certain fields to the detriment of others, and to obtain the highest returns on such investments as are made, whether they be in infrastructure building for the fishery sector or in connection with the respective phases of catching, fishery operation, industrial processing and packing or marketing of fishery products. This should be done through co-operatives, private enterprise, and public agencies concerned in the fisheries sector.

The Mexican Government is aware that the rational exploitation of its resources must be preceded by research and appraisal and is giving increasing support to its Instituto Nacional de Investigaciones Biológico-Pesqueras (National Institute of Biological and Fishery Research) whose programs place special emphasis on shrimps and prawns. Acknowledging the competence of FAO personnel, it has also applied to that international organization for technical assistance in the carrying out of a fishery research and development project. Indeed, negotiations are in the final stages calling for the investment of about 50 million pesos.

The principal purposes of this project are: research on present fishing grounds and exploration for new ones; research for the improvement of shrimp fisheries; provision of consultant services and co-operation in dealing with problems relating to industrial processing of various species of sea fauna. The Mexican Government fully recognizes the value of this project, which will use the combined financial and technical resources of our own country and of the United Nations Special Fund in the development of our fisheries.

At this time, when world tensions are so great as to worry us all, it is comforting to attend the inauguration of a conference having as its purpose the assessment of scientific data and the exchange of experience with a view to improving living conditions for many social groups and ultimately all of mankind.

The Mexican Government is well aware of your scientific and technical competence, and tenders its best wishes to your personally and for greatest success of this Conference. It welcomes you to Mexico and wishes you an enjoyable stay here.

Appendix 4

ADDRESS AT THE INAUGURAL SESSION

by

DR. S. J. HOLT
Representative of the Director-General of FAO

Mr. Chairman, Your Excellency, Ladies and Gentlemen:

I am most pleased to bring to you, on behalf of Dr. Sen, the Director-General, and of Mr. Jackson, the Assistant Director-General for Fisheries, the greetings of the Food and Agriculture Organization on the occasion of the opening of the World Scientific Conference on the Biology and Culture of Shrimps and Prawns.

My Organization, better known perhaps by the initials FAO, was most appreciative of the kind offer of the Government of Mexico to act as host to this international conference in this splendid capital city. I should, therefore, be grateful if you would kindly convey to the Minister, His Excellency Licenciado Octaviano Campos Salas, this appreciation, and also the fact that my Organization recognizes that his generous acceptance to be Honorary President of this conference confirms the importance that the Government of Mexico attaches to the development of fishing industries and to the international co-operation in this field. It seemed to us highly appropriate that the first scientific and technical discussion, global in scope, of shrimp investigations should be convened in a country which holds such a prominent place in the shrimp industry, and where at the same time the benefits to the industry that can come from scientific research are so well recognized.

The Government of Mexico has, through the agencies of its Ministry of Industry and Commerce, put tremendous care and effort into the local arrangements for this conference and we have also had a most cordial collaboration in its technical preparation. I am quite confident that the benefits of the careful preparations will be enjoyed by the participants in the conference, and that they will contribute greatly to its eventual successful conclusion.

To the appreciation of FAO for the support of the Government of Mexico I wish to add also our thanks to all those other organizations and individuals -- both in Mexico and in other participating Member Countries of FAO -- for the contributions they have been making directly to the conference and to related events in the program for the coming two weeks. In this connection, may I express a warm welcome, as guests to our conference, to the officers and members of the Shrimp Association of the Americas, which has been convening in Mexico City in the past few days and with whom we have established an excellent co-operation in the consecutive planning of the meetings. This was a particularly happy circumstance because it will facilitate the highly desirable contact between scientists on the one hand and industry on the other, which is in our view quite necessary for the stability and rational growth of fisheries.

This is the third such meeting convened by FAO to deal with the appraisal of particular types of marine fishery resources. In recent years such meetings have been held on sardines (in Rome) and on tunas (in La Jolla, California). Each of these has not only given an opportunity for the exchange of views among technical people, but has also led to a reorientation and expansion of FAO's program of work in these specialized fields, and to arrangements for continuing and strengthening international co-operation. We hope that the present conference will do likewise in relation to the rapidly growing and diversifying shrimp industry. That it will indeed do so is ensured, I think, by the fact that there will be participating in the conference about 170 experts coming from 30 countries and who have contributed over 80 technical papers for our consideration.

The world harvest of shrimp and prawns is now of the order of 600,000 metric tons annually, and, incidentally, a quarter of this is taken from the Gulf of Mexico and adjacent waters. This shrimp harvest represents not much more than one percent of the total marine catch of fish and shellfish by weight. It is, however, a harvest of a high quality product, and these species comprise nearer five percent of the world marine catch by value. This is a not inconsiderable proportion in itself, but the international importance of the shrimp fisheries is enhanced by other factors. Firstly, very many countries participate in these fisheries and at least 20 of them have major interests; secondly, more than a third of the world catch enters international trade, and many developing countries are participating in this trade with considerable benefits in earnings of foreign currencies. And thirdly, the shrimp and prawns are among the first marine fishery resources to begin to be cultivated, rather than merely hunted. The growing interest in shrimp cultivation, though as yet it is not quantitatively very important, is of particular significance today, and the conference will be giving special attention to this facet of the industry and of research. Thus, although new shrimping grounds are being discovered and opened up every year in many parts of the world, some important stocks seem already to have approached their peak of production, and we shall clearly, in coming years, need to look increasingly to ways of improving the natural resources, as well as of protecting them from overfishing and from, for example, the consequences of pollution.

I should now like to say a few words about the work of FAO in the wider fisheries context. Although since FAO was founded in 1945 it has had a Fisheries Division, at the beginning of 1966 the status of the fisheries unit was raised to that of a Department, and a six-year program of expansion was begun. At the same time a high-level inter-governmental Committee on Fisheries was established under the FAO Constitution to guide the FAO program and also - and perhaps more important - to provide a means of consultation between governments on international aspects of fishery policy. Mexico has been at the two sessions of the Committee on Fisheries since it was established last year, active as one of its 30 Member Countries. The Committee has already taken several important actions including the first steps towards the establishment of inter-governmental regional fishery organizations for the Indian Ocean and for the Middle and Southeastern Atlantic. In addition, scientific advice is being provided on fishery problems of worldwide scope by a group of eminent scientists constituting FAO's Advisory Committee on Marine Resources Research, which is now entering its fifth year of work.

Parallel with this strengthening of the headquarters unit of FAO, and the creation of new instruments for international action in fisheries, has been a very rapid growth in our efforts to assist Member Governments to develop their national fishery institutions at all levels in research, management and administration, food technology, economic planning, vessel construction, and the training of fishermen and of scientists. These efforts are being made mainly with the support of the United Nations Development Program, under which technical assistance experts are provided and more recently, on a much bigger scale, pre-investment projects are conducted under the Special Fund of the UN. To give you an idea of the scope of this assistance, I might mention that there has just been held here in Mexico City a meeting of the staff from our projects in the Caribbean-Central America region. There are now FAO fishery projects in all the Central American countries, in Cuba, and in most of the other islands of the Caribbean, in Venezuela, and in Colombia. A large Special Fund project in Mexico has recently been approved, and we in FAO look forward keenly to the much fuller collaboration with our Mexican colleagues that this will bring about. In the next year or two our field staffs in this area, and their national counterparts, will be working on ten or more research or exploratory vessels assisting in an appraisal of the fishery resources of all kinds in these waters. Shrimp studies, I may say, play a considerable part in these projects. Similar developments might be listed in South America, in Africa, and in Asia.

Meanwhile, more international funds are becoming available for investment in the fishing industries of developing countries, through the International Bank of Reconstruction and Development, and through the regional development banks. In consideration of all requests for loans from these sources, a priority question is "Are there the fishery resources available to sustain the levels of industrial development which are being planned?", thus stressing again the urgent need for the exploration and assessment of the natural resources. To get a global view of the productive capacity of known resources is one aim of a major project of FAO called the Indicative World Plan for Agricultural Development (IWP). Under this Plan, to which all FAO Member Countries are contributing, an attempt is being made to set realistic targets for food production including, of course, fish and shellfish, for the years 1975 and 1985. This is an enormously complex and difficult task, but we feel it is an important one to be accomplished if the present and future problems of world food supply - and particularly protein supply - are properly to be understood and means for their solution found.

The surge of interest in fishery development coincides with a veritable explosion of man's interest in the ocean in all its aspects. The scale of ocean research is now far, far greater than it was, say, ten years ago, and although the practical applications of this research are many and varied, surely fisheries must benefit greatly from it, directly and indirectly. Indeed, as increased food production becomes of more vital importance to human survival, we in FAO feel that everything possible must be done to secure that the ocean will provide ever-increasing and valuable harvests, and that to this end the fishery resources are fully utilized, protected and husbanded. It is now generally recognized that this will only be possible on the basis of scientific knowledge about these resources, and it is our hope - and expectation - that this world conference on shrimp and prawns will contribute to that end.

En conclusión, Señor Presidente, me permito nuevamente hacer extensivas nuestras más expresivas gracias a todas las personas que se han asociado con la Organización y que han dado tan generosamente su tiempo y sus energías en la preparación de esta Conferencia, y en particular a nuestros colegas en la Dirección General de Pesca e Industrias Conexas, a la Comisión Nacional Consultiva de Pesca, al Instituto Nacional de Investigaciones Biológicas-Pesqueras, y muy especialmente al Gobierno de México.

Muchas gracias Señor Presidente.

Appendix 5

ADDRESS AT THE CLOSING SESSION

by

DR. C. P. IDYLL
Institute of Marine Sciences, University of Miami
Chairman of the Conference

Ladies and Gentlemen:

It is appropriate at this point to look back at our World Scientific Conference on the Biology and Culture of Shrimps and Prawns and examine what we have accomplished. Many people from over 30 countries have come to the handsome capital of Mexico for our conference, some of them from half way round the world. Many people have worked long hours, sometimes neglecting other urgent matters, in order to make the conference useful and pleasant. The Government of Mexico, the FAO, and other organizations have spent a great deal of money on the organization and conduct of our conference.

Has it been worthwhile to put this time, effort, thought and money into the conference?

I believe it has. I believe that substantial immediate benefits have been achieved, but I also believe that these are small compared to greater gains which we will reap in the future from our World Shrimp Conference.

It seems to me that the chief benefits of this conference, both short and long-term, can be summarized in the phrase "Improved communications".

There have been many attempts to explain why man is the dominant animal of our planet. His upright stance, which released his hands for useful work, is among the factors leading to success, as is the possession of an apposable thumb and an enlarged fore-brain. But of course it is the successful use of these attributes that has led to man's dominance, and in my view it is the development of systems of communication which has led him farthest. And the more extensive and useful a system of communication we develop, the quicker will we achieve harmony among men and understanding of the processes which control us and our environment.

This is the essence of our World Shrimp Conference. This is why we have taken the trouble to come here -- to increase and improve our communication. I believe we have succeeded to a significant degree.

I invite you to consider what would be the nature of our lives if we were forced to act individually instead of collectively. And to act collectively, we must communicate. Of the activities of man, science is one which leans very heavily on communications. We build on each other's accomplishments; we are stimulated by each other's ideas. I believe that all of us, without exception, go from this meeting with our lines of communication improved. We have learned of work which illuminates and stimulates our own research; we have met and talked to colleagues who were only coldly printed names before, but are now flesh-and-blood friends to whom we can write with certainty of sympathetic response. In these and other ways, direct and subtle, our communication has been improved. And this could not have been accomplished except by meeting together.

If we were forced to sit at our desks and list the problems of mankind which have been solved at this meeting, we might be hard pressed. I think there have been some, including progress in attaining agreement on the standard manner of reporting statistics of landings; progress toward clarification of the definitions of some of the life

stages of shrimps; progress in compiling a more complete, more accurate, list of shrimps and prawns; progress in our understanding of culture of shrimps and the place of this technique in increasing the world food supply.

The manner that I have presented these examples is important. We have made progress toward the solution of the problem of the culture of shrimp; progress in the definition of life stages and progress in a number of other matters.

But in no case have we solved a problem forever. Sometimes we are inclined to think in terms of absolute solutions, forgetting that the truth we pursue is in fact unattainable. In few human activities - perhaps in none - are we able to produce complete solutions, acceptable and useful to everyone. Our hope is only that we can accumulate a sufficient understanding of natural processes that we can gradually learn to manipulate our environment to our advantage.

Hence we will look in vain at this conference for many accomplishments in the sense that we have solved that problem and can put it away forever.

But in an impressive number of instances we have pushed knowledge forward to one degree or another. We have new information about shrimps and prawns - new facts, new procedures, new tools, new ideas. Especially new ideas. These are the life blood of science.

One thing that I personally have gained from this conference is a realization that as a shrimp biologist I am a part of a global organization, working earnestly toward a better understanding of one important group of animals, and of a better knowledge of their reaction to their environment. The parts of this organization are loosely connected, or in some cases without connection to the whole. It is clear to me that we must improve the welding together of these parts. I am by no means suggesting that all shrimp work should be coordinated by some super-body, but I am saying that the better we understand each other's aspirations, successes and failures, the closer we will come to our particular truth.

Many of us at this conference have been heartened to realize that other scientists also have problems - sometimes, unbelievably, even worse than ours. It is encouraging to find that we have solved difficulties that others still struggle to overcome. It is helpful to find, by contrast, that someone has the solution - ridiculously simple really - to a problem that has baffled us.

What roads ahead has this conference pointed out for us?

It seems to me that the conference has been of great value in revealing more clearly where the greatest gaps were in our knowledge of shrimps and prawns. Many of us have been painfully aware of some of these, but other problems have escaped our notice. Problem-solving must always be preceded by problem definition, and we are all much better aware of these now than we were two weeks ago.

It is clear that such basic things as taxonomy need attention. This is not news to any of us, but at our conference much better focus has been possible on the specific areas where taxonomic research is required. We have had our attention called to the surprising lack of knowledge of parasitology and diseases of shrimp, and the discussions have made it clearer that these may be of fundamental importance in understanding fluctuations in abundance, and in culture methods on a commercial basis.

You must all have been impressed, as I was, with the repeated complaints that we know so little of the ecology of shrimp. We do not understand the effect of the environment on survival or movements of the young stages, and this seriously affects our understanding of variation in recruitment. The conference has made it plain that

we are equally ignorant of quantitative measures of environment pressures on adults, and this affects our ability to catch them, and to assess changes in stock size and its variation.

Summary reports of sessions have stated that for no population of shrimps and prawns do we understand the population dynamics well - the way in which the population reacts to fishing and other pressures. Indeed, only on a very few species do we have even a partial understanding of this important and complex matter. And yet we will not be able to decide whether any stock is being overfished, nor when and how to apply rational regulations, until we do have this knowledge. Reports of the sessions and the discussions are full of phrases such as "inadequate growth rate data", "sparse data on mortality rates", "age composition data are lacking", "predation rates are unknown".

We need more research on tagging and marking. We need studies of feeding efficiency and food preferences. We need information on the schooling habits of shrimps and prawns. We need improved methods of resource appraisal. There are, as one report puts it, "Vast lacunae in our knowledge of physiology and behaviour" -- the kind of knowledge required in the more efficient capture of shrimp and to improve our culture methods.

Thus we are painfully aware of the lack of knowledge in many areas of research, and of the need for better techniques. But we are encouraged by the progress reported at this conference in analyzing data by sophisticated biochemical, mathematical and computer techniques. The complicated problems of estimating survival rates, predation rates, growth rates and other problems are still only partially solved, but these look easier as a result of work discussed here.

One of the dominating interests of the conference has been in shrimp culture. Over the world, both among oceanographers and the general public, enthusiasm runs high over the possibility of increasing our food supply through aquatic forms. I am afraid popular enthusiasm is greater than professional enthusiasm in this area and that, through ignorance of the problems, the layman expects more than can be delivered. It is my opinion that marine farming on a large scale is many years in the future, and that it never will replace or even compete with the capture of wild stocks in terms of quantities of food produced. And yet, marine brackish water farms will exist in the future, and they will produce useful quantities of food. Furthermore, I believe that shrimp farms will be among the first successful of such establishments. Indeed, this is already the case, our Oriental colleagues having shown us the way. The nature of the shrimp - high value, fast-growing animals living near the base of the food chain, or in a dominant position in the food web, to use a more appropriate simile - makes them good material for our first awkward attempts at this highly complicated and difficult job. I am hopeful that we can soon learn so much from trials at shrimp culture that we will be able to establish farms for many other marine animals, invertebrate and vertebrate.

The key to this problem, as with most of those we face eventually, is an economic one. We can already produce shrimp and some other animals in tanks and ponds. The trick is to produce them at a profit. This looks either difficult or impossible - depending on the species and the particular economy - from where we sit today but I predict that we will succeed in this endeavour, probably faster than most of us think. And our meeting here has pushed us forward on this important road. We must assemble again in not too many years to urge it still farther forward.

We must not lose the momentum that this conference has created. We must continue the associations we have established. All of us will do this on a personal basis, but in addition, there must be some official machinery, through FAO, to sustain our forward motion. To this end the conference has created several working parties, concerned with

statistics, with taxonomy of shrimps, with classification and definition of young stages and with other matters. We have suggested to FAO that they examine how best to maintain formal liaison among shrimp scientists over the world, and we will be eager to see that this develops quickly and effectively.

I took the occasion last night to point out the gratitude all of us have to those who have worked so hard to organize and run this conference. Without repeating names I will say again how grateful we are to the staff of the FAO, to the Convenors and Rapporteurs who gave up technical sessions and entertainment to work on their reports; to members of the Consultative Committee who helped shape the conference and ensure its success; to the interpreters who did such a skillful job; to the cheerful and efficient helpers all down the line.

I cannot close without repeating thanks on my own behalf and on the part of every participant, whole-hearted and warm gratitude to our Mexican hosts for their extraordinary generosity and kindness. I expressed this at the dinner last night and what I said then I will not attempt to repeat, to avoid further damage to the beautiful Spanish language. But I have had scores of comments from the delegates expressing their amazement and pleasure at the brilliance of the social events and at the generosity of our Mexican hosts. I can only say again: "Thank you. Your efforts are deeply appreciated".

Appendix 6

PROGRAM OF SOCIAL EVENTS ORGANIZED BY THE MEXICAN GOVERNMENT

Monday,	12 June 1967	Reception at Bazar Sábado
Tuesday,	13 June	Visit to the National Museum of Anthropology and History Reception
Wednesday,	14 June	Mexican Folklore Ballet, Palace of Fine Arts
Thursday,	15 June	Tour of Mexico City Visit to the Natural History Museum Reception
Saturday,	17 June	Visit to the archeological area of San Juan Teotihuacán
Sunday,	18 June	Tour of Xochimilco Lake Luncheon at Frigorífico de Tepepan, Xochimilco
Monday,	19 June	Visit to the ancient Convent of Tepotzotlán Reception
Tuesday,	20 June	Banquet, Hotel María Isabel
Thursday, Saturday,	22 June to 24 June	Guided visit to Mérida, Campeche, Uxmal and Chichén-Itzá

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	2	Biology of potentially valuable fresh-water prawns with special reference to the riceland prawn *Cryphiops* (*Macrobrachium*) *lanchesteri* (de Man)	Johnson, D.S.
	3	Relation of temperature to growth and self-propagation of *Pandalus borealis* in Newfoundland	Squires, H.J.
	4	Food and feeding of some Australian penaeid shrimp	Dall, W.
	5	Reproduction of the sand shrimp, *Crangon crangon* (L.)	Meixner, R.
	6	Size distribution and movement of the commercial prawns of the southwest coast of India	George, M.J., Banerji, S.K. and Mohamed, K.H.
	7	Maturation and spawning of the penaeid prawns of the southwest coast of India	Rao Vedavyasa, P.
	8	Las gambas de interés comercial en España	Massuti, M.
	9	Automatic processing of Western Australian prawn fishermen's log-books	Slack-Smith, R.J. and Stark, A.E.
	10	Frecuencia de camarón postlarval (*Penaeus* Fabricius 1798) relacionada con la temperatura y salinidad en la costa de Ciudad Madero, Tamaulipas	Macías Ortiz, J.A.
	11	Contribución al estudio de la biología del camarón café *Penaeus californiensis*	Olguín Palacios, M.
	12	Ensayo de interpretación de las tallas comerciales de camarón en los litorales de Sonora, México	Chapa S., H. Guilbott T., C. y Romero R., H.
	13	Contribución al conocimiento de los Palemónidos de México: III Palemónidos del Golfo de California, con notas sobre la biología de *Macrobrachium americanum* Bate	Rodríguez de la Cruz, M. C.
	14	The determination of some stages of the molting cycle of *Penaeus duorarum*, by microscopic examination of the endopodites of pleopods	Schafer, H. J.

1/ Abstracts in English, French and Spanish

FR : BCSP/67/E/15		Storage materials utilized by starved pink shrimp, Penaeus duorarum Burkenroad	Schafer, H. J.
	16	Estudio preliminar sobre las migraciones de postmisis de Penaeus vannamei Boone	Guerrero, L. L.
	17	Morfología de Macrobrachium acantharus (Wiegman) en el Estado de Veracruz, Mexico	Carrillo V., F.
	18	Observations on the paddy-field prawn filtration of Kerala, India	George, M.J. Mohamed, K.H. and Pillai, N.K.
	19	Stock assessment in the shrimp (Heterocarpus reedi) fishery of Chile	Hancock, D.A. and Henríquez, G.
	20	Some aspects of the biology of Solenocera indica Nataraj	Kunju, M.M.
	21	Postlarvae of penaeid prawns of southwest coast of India with a key to their indentification	Mohamed, K.H., Rao, P.Vedavayasa and George, M.J.
	22	Some aspects of the biology of white shrimp Penaeus schmitti Burkenroad, in Lake Unare, Venezuela	Khandker, M. Alam
	23	The design and field testing of an electro-shrimp trawling system	Pease, N.L.
	24	The shrimp fishery of British Columbia	Butler, T.H.
	25	Osmotic behaviour of shrimps and prawns in relation to their biology and culture	Panikkar, N.K.
	26	Relaciones entre largos y pesos de camarones capturados en la plataforma cubana	Cruz Morejón, N. y Cadima, E.
	27	General remarks on the design, analysis and evaluation of fishery resource surveys	Stark, A.E. and Slack-Smith, R.J.
	28	Presencia de algunos estadios larvales de peneidos en un área camaronera al sur de Cuba	de la Cruz S., A.
	29	Diez viajes de exploración con el barco CAMARON I en la plataforma sudoriental de Cuba	Nikolić, M. y García S., R.
	30	The general biology and development of Macrobrachium rosenbergii (de Man)	Ling, S.W.
	31	Methods of rearing and culturing Macrobrachium rosenbergii (de Man)	Ling, S.W.
	32	Consideraciones sobre los índices metabólicos y la supervivencia del camarón blanco, Penaeus schmitti Burkenroad, de la plataforma cubana	Suárez A., G. y Xiqués D., R.
	33	Penaeid shrimp catch and heat summation, an apparent relationship	Williams, A.B.

FR : BCSP/67/E/34	A descriptive and analytical model of the Shark Bay prawn fishery	Slack-Smith, R.J.
35	The use of predator food habits in estimating relative abundance of the ocean shrimp, Pandalus jordani Rathbun	Gotshall, D.W.
36	Recherches sur le cycle biologique de la crevette Penaeus duorarum Burkenroad 1939 au Dahomey	Hoestlandt, H.
37	A method of rearing penaeid shrimp larvae for experimental studies	Cook, H.L.
38	The prawn fishery of Shark Bay, Western Australia	Slack-Smith, R.J.
39	The prawn fishery resources of India	Jones, S.
40	Commercial prawns of West Pakistan	Tirmizi, N.M.
41	The Venezuelan shrimp fishery	Ewald, J.J.
42	Predicting brown shrimp abundance in the northwestern Gulf of Mexico	Berry, R.J. and Baxter, K.N.
43	The biology and distribution of the northern shrimp in the Bering Sea and the Gulf of Alaska	Ivanov, B.
44	Kuruma shrimp (Penaeus japonicus) cultivation in Japan	Fujinaga, M.
45	Crecimiento, migración y ecología del camarón comercial, Artemesia longinaris Bate	Boschi, E.E.
46	Observations on the shrimp fisheries of the central and southern coast of Brazil	Neiva, G. de S.
47	Larval and postlarval pink shrimp (Penaeus duorarum) in South Florida	Roessler, M.A., Jones A.C. and Munro, J.L.
48	On the mechanisms underlying tide-associated movements of Penaeus duorarum Burkenroad	Hughes, D.A.
49	The relation of rainfall and fresh-water drainage to the production of the penaeid shrimps (Penaeus fluviatilis Say and Penaeus aztecus Ives) in Texas and Louisiana waters	Gunter, G. and Edwards, J.C.
50	Pandalus borealis in Greenland waters: its fishery and biology	Smidt, E.
51	The commercial prawn Macrobrachium malcolmsonii (H.M. Edwards) of the River Godavary, a discussion on the trends and characteristics of the population during 1963-66	Rajyalakshmi, T. and Ranadhir, M.
52	Some observations on the biology of the freshwater shrimp, Macrobrachium lanceifrons (Dana), with notes on the fishery	Rasalan, S.B., Delmendo, M.N. and Reyes, T.G.,

FR : BCSP/67/E/53		Abbreviated larval development in caridean shrimps and its significance in the artificial culture of these animals	Dobkin, S.
	54	Detailed shrimp statistical program - Gulf States	Snow, G.W.
	55	Oxygen consumption of the prawns Penaeus indicus H. Milne Edwards and Penaeus semisulcatus de Haan	Kutty, M.N.
	56	Factors controlling the time of emergence of pink shrimp Penaeus duorarum	Hughes, D.A.
	57	Discarding practices in the Gulf of Mexico shrimp fishery	Berry, R.J. and Benton, R.C.
	58	White shrimp emigration in relation to size, sex, temperature and salinity	Pullen, E.J. and Trent, W.L.
	59	An appraisal of the effects of salinity and temperature on growth and survival of post-larval penaeids	Zein-Eldin Z.P. and Griffith, G.W.
	60	Prediction of the success of commercial shrimp fishing on the Tortugas Grounds based on enumeration of emigrants from the Everglades National Park Estuary	Yokel, B.J. Iversen, E.S. and Idyll, C.P.
	61	A computer program for handling data on the abundance of shrimp and associated animals	Thomas, T.M. and Fishback, C.L.
	62	Problemas de especiación en América de un grupo de Palaemonidae del género Macrobrachium	Villalobos-Figueroa, A.
	63	The suitability of the English prawn Palaemon serratus (Pennant) for cultivation - a preliminary assessment	Reeve, M.R.
	64	Distribution and density of prejuvenile Penaeus shrimp in Galveston Entrance and the nearby Gulf of Mexico (Texas)	Kutkuhn, J.H. Cook, H.L. and Baxter, K.N.
	65	Variations in protandric hermaphroditism of Pandalus borealis	Rasmussen, B.
	66	Notas biológico-pesqueras sobre camarón blanco Penaeus schmitti Burkenroad 1936	Nikolić, M. and Ruiz de Quevedo, M.E.
	67	A brief history of Florida's live bait shrimp fishery with description of fishing gear and methods	Tabb, D.C. and Kenny, N.
	68	Microsporidosis in commercial penaeid shrimp	Iversen, E.S.
	69	Posibilidades para incrementar la producción camaronera de alta mar en las aguas del Océano Pacífico frente a México	Mendoza von Borstel, J.

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FR : BCSP/67/R/1		The type of development of prawns as a factor determining suitability for farming	Williamson, D.I.
	2	Prawn culture in Singapore	Tham Ah Kow
	3	The biology of mass occurrences of galatheid crustaceans and their utilization as a fisheries resource	Longhurst, A. R.
	4	A review of the culture of sugpo, Penaeus monodon Fabricius, in the Philippines	Caces Borja, P. and Rasalan, S.B.
	5	Techniques of finding and catching shrimp in commercial fishing	Kristjonsson, H.
	6	Observaciones sobre las medidas de control de los recursos acuáticos vivientes con referencia especial al camarón	Miles, C.

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FR : BCSP/67/RS/1		Unit stocks of shrimps and prawns in the IPFC region and unit fisheries exploiting them	Tham Ah Kow

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FR : BCSP/67/SS/1		The common shrimp Crangon crangon (Linnaeus, 1758)	Tiews, K.
	2	The shrimp Pandalus montagui Leach 1814	Simpson, A.C.
	3	The jumbo tiger prawn Penaeus monodon Fabricius 1798	Mohamed, K.H.
	4	The Indian prawn Penaeus indicus H. Milne Edwards 1837	Mohamed, K.H.
	5	The prawn Pandalus platyceros Brandt 1851	Butler, T.H.
	6	The penaeid prawn Solenocera indica Nataraj 1945	Kunju, M.M.
	7	The penaeid prawn Metapenaeus dobsoni (Miers) 1878	George, M.J.
	8	The penaeid prawn Metapenaeus affinis (H. Milne Edwards) 1837	George, K.J.
	9	The ocean shrimp Pandalus jordani Rathbun 1902	Dahlstrom, W.A.
	10	Camarón blanco Penaeus schmitti Burkenroad 1936	Perez Farfante, I.
	11	White shrimp Penaeus setiferus (Linnaeus) 1767	Lindner, M.J. and Cook, H.L.

Information papers

FR : BCSP/67/INF/1		Crustaceans/Crustacés/Crustáceos 1965 Bulletin of Fishery Statistics	FAO Fishery Statistics and Economics Data Branch
	2	List of species of shrimps and prawns of economic value	Holthuis, L. B. and Rosa, H.,Jr.

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